INSULATED WALL PANEL FOR BUILDING CONSTRUCTION AND METHOD AND APPARATUS FOR MANUFACTURE THEREOF

Inventor: Michael P. Nichols, Texas City, TX (US)

Correspondence Address:
JAMES L. JACKSON
JAMES L. JACKSON, P.C.
10723 Sugar Hill Drive
Houston, TX 77042 (US)

Appl. No.: 11/137,726
Filed: May 25, 2005

Publication Classification

Int. Cl.
E04C 1/00 (2006.01)

U.S. Cl. ......................................................... 52/309.8

ABSTRACT

Pre-fabricated wall, ceiling and roof panels for use in building construction have a metal framework, metal interior bracing as needed and may include internal electrical, water and gas supply conduits enabling simple and efficient building construction. A method for manufacturing the pre-fabricated building panels includes constructing a metal panel framework with internal structural bracing and placing the framework in a machine having relatively moveable foam containment plates. Polyurethane foam panel filler material having efficient thermal insulating quality is injected into the panel frame between the foam containment plates and expands during curing to fill the voids within the panel frame and define parallel exterior and interior panel surfaces. The light-weight polymer foam filled panels are then secured to the panel connectors of a building foundation and are secured to one another to define the walls, ceiling and roof a building structure and provide resistance to storm damage, insect and water damage and heat reflection.
INDICATED WALL PANEL FOR BUILDING CONSTRUCTION AND METHOD AND APPARATUS FOR MANUFACTURE THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

This invention relates generally to pre-fabricated wall, ceiling and roof panel structures for use in building construction. The invention also concerns a method of manufacturing pre-fabricated building panel structures incorporating metal panel framework and structural bracing and having polymer foam panel filler material that is installed in finished metal panel frames to ensure the structural integrity of the panels and provides excellent thermal insulation characteristics that minimize the energy requirements for air-conditioning and heating the interior of a building to maintain a comfortable thermal environment.

More particularly, the present invention also concerns a machine and manufacturing system for manufacturing the building construction panels and a method for manufacturing pre-fabricated insulated wall and roof panels.

[0002] 2. Description of the Prior Art

It is well known that various types of prefabricated building panels for the walls and roofs of buildings have been developed for the building construction industry, and many of these panels incorporate polymer foam material because of its excellent thermal insulation quality. In many cases the polymer foam insulation is simply placed loosely within cavities of the wall or roof panel structures. In some cases the mixed “A” and “B” constituents of the polymer foam is placed within panel cavities in its uncured state and is permitted to become expanded and cured in-situ. It is known, however, that uncured polyurethane foam material tends to expand non-uniformly, so that it is virtually impossible for polyurethane foam insulation to create planar interior and exterior polymer foam panel surfaces without subsequent panel preparation after the polyurethane foam material has become completely cured. It is also known that curing and expanding polyurethane foam material will generate very high pressure if curing and expansion takes place within a confined space. Significant panel manufacturing problems will typically occur if wall and roof framework closure panels are applied to the panel framework in order to confine the expanding polyurethane foam in an attempt to create parallel exterior and interior planar panel surfaces.

[0003] Pre-fabricated construction panels or structural insulated panels (SIP) incorporating polymer foam material for thermal insulation have been developed. The most common types of expanded polymer foam used in the SIP industry are expanded polystyrene (EPS) and extruded polystyrene (XPS) materials. Traditionally, the polymer foam core is encased in oriented strand board (OSB), i.e., wood, or other organic board materials. When wood and other organic materials are employed for the development of structural insulated panels for the wall and roof structures of buildings, insect damage, water damage and dry rot are significant problems that affect the durability of such structures. The OSB encasement material typically provides a path for ingress and egress of termites and other such insects. One significant benefit of using metal as the panel framework material and avoiding the use of wood and paper as panel encapsulation or lining materials is that insects, such as termites, are not attracted to metal, polyurethane foam insulation and other non-organic materials. Also, polyurethane foam insulation provides for efficient sealing at the joints of a building structure, thus efficiently excluding crawling insects such as roaches, ants and the like from access to the interior of a building through the insulated wall structure thereof. The polyurethane foam insulation material is sufficiently flexible that cracks, which typically develop in conventional building structures due to thermal expansion and contraction of building components, do not tend to occur in steel building structures having polyurethane foam insulation filling the voids of wall and roof panels. Thus, for substantially insect-free building structures, metal panel framework material and cured in-situ polyurethane insulation completely filling the panel framework voids are materials of choice.

SUMMARY OF THE INVENTION

[0006] It is a principle feature of the present invention to provide pre-fabricated building panels that incorporate a panel framework composed of lightweight metal sheet material that is formed to desired configuration and have internal structural braces as desired that are also composed of formed metal sheet material and further having a thermal insulating polyurethane foam material formed in situ and filling the voids of the framework and defining exterior and exterior substantially parallel panel surfaces;

[0007] It is also a feature of the present invention to provide structural insulated panels that can be used effectively in timber framed, steel framed, and log homes and can be employed in multi-unit buildings and light commercial buildings;

[0008] It is a feature of the present invention to provide structural insulated panels that can be used effectively to define interior supporting walls of a building and for adding seismic strength, sound absorption and fire separation to building structures and to provide storm resistant wall, roof and ceiling structures for buildings;

[0009] It is a feature to provide novel structural insulated metal reinforced roof panels and galvanized steel overlapping roofing panel combination that provide a roofing system that effectively resists hail damage, wind damage and provides extended service life in a wide range of environmental conditions;

[0010] It is another feature of the present invention to provide a novel method for manufacturing pre-fabricated building panels having a metal frame-work and incorporating polyurethane-foam filler material for its excellent thermal insulating quality and for its facility for addition of significant structural integrity to the resulting panel structure.

[0011] It is also feature of the present invention to provide a novel manufacturing system for construction of a metal framework composed of formed sheet metal that is formed to desired cross-sectional configuration to define perimeter frame members and internal structural members of the framework.

[0012] It is an even further feature of the present invention to provide a novel manufacturing mechanism for supporting a metal construction panel framework and confining polymer foam expansion to framework voids and for defining
internal and external panel surfaces to essentially provide thermal insulated wall panels having all of the internal voids thereof substantially filled with polymer foam material to enhance the structural integrity of the panels and to ensure desired thermal insulating capability thereof.

[0013] It is a feature of the present invention to provide a novel pre-fabricated thermal insulated roof panel construction having a metal framework being completely filled with polyurethane foam material and having heat reflective metal roofing to enhance the thermal insulating quality of the roof structure of a building.

[0014] It is a feature of the present invention to provide a novel pre-fabricated thermal insulated wall or roof panel construction which is completely filled with polyurethane foam material that is formed in-situ and which enhances the resistance of a building to fire since a quantity of air is not present within the foam filled wall and roof panels.

[0015] It is a feature of the present invention to provide a novel pre-fabricated thermal insulated wall or roof panel construction being substantially completely filled with polymer foam insulating material and to provide one or more service components for electrical service conductors to minimize the construction time and labor expense that is typically required for the construction of buildings.

[0016] Briefly, the principles of the present invention are realized through the provision of pre-fabricated insulated wall, ceiling and roof panels that are assembled at a construction site to form the wall and roof structures of a domestic or commercial building. A building having walls, ceilings and/or roof structures that are defined by pre-fabricated insulated construction panels is caused to be essentially non-flammable since air is not present within the construction panels. Also, by being composed of inorganic materials the building structure is provided with protection from damage by insects and environmental conditions such as the rain and wind of storms. The pre-fabricated insulated construction panels of the present invention also ensure efficient thermal insulation of a building, thus minimizing the costs of heating and cooling.

[0017] The wall and roof panels of buildings constructed according to the principles of the present invention are composed of metal frameworks that are substantially completely filled with polyurethane foam material that is formed in situ. The polyurethane foam material essentially excludes air from the space or voids of the metal framework and provides excellent resistance to the propagation of fire through the walls and roof of a building. Sheet steel material, preferably having a galvanizing coating of zinc and tin material, is formed to define substantially straight metal structural members having a generally C or U shaped cross-sectional configuration. Typically these structural members are of generally rectangular configuration and are designed to provide substantially the same wall thickness as if standard planed 2’x4’ wood material were used for wall studs. Thus, the rectangular structural members have a dimension in the range of about 1/8” by about 3/8”. If desired, however, metal structural members of other dimension may be used as well. Internal and external perimeter panel frame members are arranged with the interior and exterior flanges thereof in overlapping relation. These overlapping flange members are secured in assembly by means of fastener devices such as screws, rivets or the like.

Depending on the dimension and configuration of the intended thermally insulated wall panels interior longitudinal and transverse structural members, also composed of galvanized sheet steel or other suitable sheet metal material are placed in assembly with the perimeter frame members and secured by means of suitable fasteners.

[0018] For the manufacture of completed wall and roof panels having a metal panel framework and having the voids thereof completely filled with polyurethane foam material, cured in situ under pressure, the resulting wall panel frame structure is placed on a generally flat lower support plate. The lower support plate and an upper foam expansion resistance plate are moved relative to one another for establishing forceful engagement of the plate members with a panel framework. Typically, the lower plate member is maintained static and the upper plate member is moved downwardly into force resisting engagement with the upper portion of the horizontally oriented panel frame structure.

[0019] The upper foam expansion resistance plate and the lower support plate essentially close the internal voids of the panel frame structure and define form surfaces establishing planar wall surfaces of the polyurethane foam insulation as the polymer foam expands in-situ. The A and B constituents of the polyurethane foam material are conveyed to the mixing chamber of one or more polymer foam injection guns where the constituents are mixed. A measured quantity of the mixed A and B liquid constituents are then conveyed through injection tubes that are extended through holes in top or bottom perimeter frame members and the mixture is injected to selective internal regions or voids of the framework that is closed by the upper and lower plate members. The A and B constituents of the polyurethane foam material polymerize within the voids of the framework structure and expand to a foam characteristic during polymerization. As the mixed constituents polymerize a resulting polyurethane foam is generated which expands to fill all of the internal voids of the panel frame structure, including filling the voids of the various hollow sheet metal structural members. The expanding polyurethane foam material also comes into intimate contact with the planar surfaces of the upper and lower plates, thus forming planar internal and external panel wall surfaces and minimize the need for additional preparation for use in the construction of a building.

[0020] The quantity of polyurethane foam mixture that is injected into the framework structure develops an internal foam pressure that is significantly great to force the polyurethane foam into even the smallest interstices within the framework structure and also applies foam pressure to the upper and lower plate members. This polymerization induced foam pressure causes the resulting polyurethane foam to have greater density than if its curing occurred in absence of the foam pressure. Confinement of the polyurethane foam material during its expansion develops an inter- nal foam pressure that enhances complete filling of the panel voids and enhanced the density and structural integrity of the polymer foam body and thus the panel structure. The foam pressure also causes the expanding foam body to engage the flat surfaces of support and foam expansion resistance plates and thus define parallel planar wall surfaces of the panel. This more dense polyurethane foam develops significantly greater structural integrity that enhances the structural integrity of the completed wall and roof panels.
filling the interior voids of the panel frame structure during polymerization of the polyurethane foam, voids or channels in the foam material do not occur, thus prevent the possibility of fire propagation through the foam core of the construction panels. The upper and lower plates restrain the expanding polyurethane foam material and function to define substantially flat internal and external panel wall surfaces. Typically, the finished polyurethane filled metal panel framework structures require no additional finishing processes prior to use in the construction of the walls and roof of a building.

[0021] Electrical boxes and conduits maybe incorporated within the polyurethane foam body of the thermally insulated wall panels to simplify the construction procedure and to minimize the costs for buildings that are erected by installation of the prefabricated wall panels of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] So that the manner in which the above recited features, advantages and objects of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the preferred embodiment thereof which is illustrated in the appended drawings, which drawings are incorporated as a part hereof.

[0023] It is to be noted however, that the appended drawings illustrate only a typical embodiment of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0024] In the Drawings:

[0025] FIG. 1 is an elevational view showing a pre-fabricated insulated building panel that embodies the principles present invention and incorporates a metal panel framework and a body of polymer foam thermal insulating material filling the voids of the framework and enhancing the structural integrity of the panel structure;

[0026] FIG. 2 is an isometric illustration of a pre-fabricated thermally insulated building panel embodying the principles of the present invention;

[0027] FIG. 3 is a sectional view taken along line 2-2 of FIG. 1 showing the polymer foam material thereof completely filling the voids of the metal panel framework;

[0028] FIG. 4 is an alternative sectional view taken along line 2-2 of FIG. 1 and showing control of the thickness of the polymer foam insulating material for control of the thermal insulating quality of the resulting pre-fabricated panel by displacement during positioning and curing of the polymer foam material;

[0029] FIG. 5 is a side elevational view of a pre-fabricated insulated building panel, showing angulation of the upper end of a panel as desired for establishment of the pitch of the roofing of the building structure;

[0030] FIG. 6 is a sectional view illustrating the cross-sectional configuration of the panel perimeter members and internal structural members of the framework of a pre-fabricated insulated wall panel;

[0031] FIG. 7 is an elevational view showing a pre-fabricated insulated building panel of generally triangular configuration, such as for filling the gabled ends of a roof structure;

[0032] FIG. 8 is an elevational view of a mechanism for supporting and confining metal panel framework structures to enable controlled filling of the voids of a building panel framework with polymer foam material;

[0033] FIG. 9 is an end elevational view of the panel frame support and confining mechanism of FIG. 8;

[0034] FIG. 10 is an elevational view showing an insulated wall panel of the present invention and showing an electrical box and conduit contained within the internal urethane foam body thereof;

[0035] FIG. 11 is an elevational view of a pre-fabricated insulated wall panel having a plurality of service boxes and electrical conduits embedded within the wall structure, such as for electrical service, typically light or circuit switches, or for telephone service, television cable and the like;

[0036] FIG. 12 is an elevational view showing a pre-fabricated insulated wall panel of the present invention having structural members of the panel framework thereof arranged for mounting a small window assembly, such as a bathroom window, in the panel opening subsequent to assembly of the panel to form part of the wall structure of a building;

[0037] FIG. 13 is an elevational view showing a pre-fabricated insulated wall panel of the present invention having structural members of the panel framework thereof arranged for mounting a door in the panel structure and further showing electrical service boxes and conduits incorporated within the panel framework structure;

[0038] FIG. 14 is an elevational view showing a pre-fabricated insulated wall panel of the present invention having structural members of the panel framework thereof arranged for mounting a door and electrical service boxes and conduits in the panel structure;

[0039] FIG. 15 is an elevational view showing a pre-fabricated insulated wall panel having embedded within the polyurethane foam a plurality of service boxes and conduits for electrical, telephone and television cable services;

[0040] FIG. 16 is an elevational view showing a pre-fabricated insulated wall panel with the panel framework structure defining an opening within which a window assembly is to be mounted;

[0041] FIG. 17 is an elevational view showing a pre-fabricated insulated wall panel with the panel framework structure defining an opening within which a window assembly is to be mounted and showing electrical service boxes located beneath the window opening;

[0042] FIG. 18 is a view, with parts thereof broken away, showing a pre-fabricated insulated roof or ceiling panel constructed according to the principles of the present invention and being shown with a lighting fixture mounted fixed thereto;

[0043] FIG. 19 is a side view of the roof panel structure of FIG. 18, showing tapered ends thereof being tapered according to the intended pitch of the roof of a building;
FIG. 20 is a plan view showing an anchoring member for establishing anchoring of pre-fabricated wall panels to a concrete foundation for enhancing the resistance of a building to the force of wind; and

FIG. 21 is a side elevational view showing the anchoring member of FIG. 20 in relation to a concrete foundation and showing a portion of a wall mounting track being fastened thereto.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawings and first to FIGS. 1-6 and FIGS. 10-19, a thermally insulated structural panel for the construction of buildings is shown generally at 10 and comprises a metal framework having generally straight side perimeter frame members 12 and 14, a top perimeter frame member 16 and a bottom perimeter frame member 18. Each of the perimeter frame members is of generally U-shaped cross-sectional configuration, as shown in FIGS. 2 and 3 and particularly in FIG. 6. The perimeter frame members and internal panel studs are composed of sheet metal, typically 20 gauge galvanized steel that is bent to the desired generally rectangular cross-sectional configuration having a central web 11 defining the typically four perimeter edges of an insulated wall panel structure. The perimeter frame members each also define interior and exterior generally parallel flange members 13 and 15 that are integral with the central web 11. The interior and exterior generally parallel flange members 13 and 15 each define edge flanges 17 and 19 that are generally oriented in substantially normal relation with the respective interior and exterior flange members 13 and 15. If desired, however, the edge flanges 17 and 19 may simply be rolled to a substantially curved configuration. The exterior frame members are connected to one another by means of suitable metal fasteners 20, such as screws, rivets, or the like that extend through overlapping flanges. In FIGS. 1-4, the exterior framework is shown as being of generally rectangular configuration, such as for use in the construction of exterior walls of buildings. However, as shown in FIG. 5, the exterior panel framework may be of triangular configuration, such as for use in the construction of the gabled ends of buildings that are designed with hip roof structures. It should also be borne in mind that the exterior framework of thermally insulated building panels may define any other suitable exterior configuration that is suitable for forming a portion of the external wall structure of a residential building or any other building structure.

It should be borne in mind that the pre-fabricated insulated building panels may have differing height and width according to the design of the building structure that is intended. Some panel structures may be designed with door frames, window frames and the like within which door and window assemblies may be mounted. The wall panels may also be provided with embedded electrical boxes and conduits during panel manufacture, enabling the residential services, such as electricity, telephone and television cable, to simply be connected with a minimum of effort during the building construction phase. Some panel structures may be designed to form portions of garage door openings, window openings and door openings, thus providing to ease of installation of one or more garage doors or entry and exit doors in a particular building structure.

The thermally insulated building panels are particularly designed for use in constructing the exterior thermally insulated walls of a building to provide a thermally insulated enclosure to minimize the cost of heating and air-conditioning of the building. The roof structure of a building may also be composed of thermally insulated roofing panels to cooperate with the thermally insulated wall panels for construction of a thermally insulated building. If desired, thermally insulated ceiling panels may also be utilized for building construction especially if the volume of the interior, air-conditioned space of the building is intended to be minimized. Typically, the spaces between the ceiling joists, which are preferably composed of metal, but maybe composed of wood or any other suitable ceiling joist material, will be filled with laid or blown-in thermal insulation material in conventional fashion. It should be borne in mind, however, that the ceiling of a building structure may also be composed of pre-fabricated thermally insulated panels within the spirit and scope of the present invention. Wall, ceiling and roof structural members of thermally insulated building structures of this character are preferably composed of metal to minimize deterioration of building components by rot or by infestation of termites and other insects. Interior walls of this type of building construction are preferably composed of conventional metal wall studs and dry wall panels that are fixed to the wall studs by means of self-tapping sheet metal screws or other suitable fasteners.

The thermally insulated building panels preferably include interior structural members when the physical size thereof so warrants. As shown in FIGS. 1-4 and 6, longitudinal interior structural members 22 and 24 are shown to be fixed to the top and bottom exterior structural members 16 and 18 by means of suitable fasteners. The interior structural members are preferably composed of sheet metal, such as steel, plated or galvanized steel, aluminum, of which they may be composed of extruded metal such as aluminum alloy. The interior structural members may also be composed of various non-metal materials such as filled fiberglass, polymers or composites having sufficient structural integrity to provide building panels of desired strength and durability. Plated or galvanized steel is the material of choice, since the wall and roof panels of the building structure must be capable of withstanding significant wind load, such as is typically encountered during thunderstorms, hurricanes, tornadoes and the like. Tests of thermally insulated building panels conducted according to the principles of the present invention have been conducted according to ASTM E 330 (Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference) by Architectural Testing of 2865 Market Loop, Suite B, Southlake, Tex. 76092. These tests have determined that the thermally insulated building panels of the present invention are capable of withstanding wind load in the range of up to 200 mph without becoming damaged or destroyed.

The thermally insulated building panels also typically include partial or transverse internal structural members 26 and 28, though as shown in FIGS. 10-17 transverse structural members may not be required. These structural members are also preferably composed of bent plated or galvanized steel sheet material due to the excellent strength and durability of steel, but may be composed of a wide variety of metal or non-metal materials and composite materials as well. Preferably, the lateral or transverse internal structural members 26 and 28 are also of generally C or U-shaped cross-sectional configuration, though they may be
of any other suitable configuration that enhances the desired structural integrity of the panel framework structure. Also, more or less longitudinal and lateral interior structural members may be provided in the panel framework assembly than shown, without departing from the spirit and scope of the present invention.

[0051] As shown in FIG. 5, the exterior top member 16 of the panel framework 10 may be angulated as shown, according to the pitch of the roof of the building for which the insulated wall panel is intended. A generally triangular insulated wall panel is shown generally at 30 in FIG. 6 and comprises exterior panel framework members 32, 34 and 36. The exterior and interior panel framework members are secured in immovable assembly by means of suitable fasteners such as screws, rivets, bolt and nut assemblies and the like. Preferably, the exterior and interior panel framework members are composed of galvanized steel sheet material that is bent to a suitable, typically rectangular cross-sectional configuration. The triangular panel framework is filled with polyurethane foam material according to the process that is described in detail herein.

[0052] For purposes of providing the panel framework, regardless of its configuration, with a desired thermally insulating quality and for enhancing the structural integrity of the panel structures, the internal voids of the panels are filled with a desired quantity of polymer foam material 42. Though a wide variety of thermally insulating polymer foam materials may be employed, presently the polymer foam material of choice is polyurethane, which is developed by mixing A and B polyurethane components and causing a polyurethane foam to develop due to polymerization. Typically, as the polymer constituents are mixed by a polymer mixing and injecting mechanism or “gun” which causes the polyurethane foam to expand during polymerization, thus completely filling the interior voids between the exterior and interior structural members of the framework. Also, it is desirable that finished pre-fabricated insulated building panels have substantially planar interior and exterior wall surfaces. To provide these generally parallel and generally planar wall surfaces, the polymer foam material confined during its expansion due to polymerization and is prevented from expanding beyond the internal and external planes of the framework. Thus, during its polymerization expansion the polymer foam is caused to flow or expand into even the smallest voids of the framework, such as the spaces within the structural members. The result is substantially completely filled panel frames which provide excellent thermal insulation for the building within which the frames are located.

[0053] The pre-fabrication process for the insulated building panels comprises forming the interior and exterior framework structural members from sheet steel material by means of metal forming machinery accomplishing controlled bending thereof. The formed exterior and interior framework structural members are initially assembled by hand or by means of a jig and are secured in assembly by means of suitable fasteners, particularly self-tapping sheet metal screws. The framework members may also be assembled by welding, such as spot welding; however, the sheet material from which the framework members are formed is quite thin, having a thickness in the order of from about 0.01 inch to about 0.04 inch, typically sheet metal having a thickness of about 20 gauge, assuming the sheet material is galvanized steel. Preferably, according to the present method of assembly, self-tapping sheet metal screws are used to secure the structural components of the panel framework in substantially immovable assembly.

[0054] The assembled panel framework is then placed on a flat support plate member to ensure that the exterior surface of the resulting prefabricated wall, roof or ceiling panel will be as planar as possible. An upper plate member is then moved into expansion resisting contact with the upper portion of the supported framework. Thereafter, polymer foam material is injected within the mixing chamber of a polymer foam injection gun and is injected into the major voids between the exterior and interior frame members. As the polyurethane foam material polymerizes, the foam will expand. After coming into contact with the upper and lower plate members expansion of the polyurethane foam material beyond the planar surfaces of the plate members is prevented by the resistance of the plate members. Curing of the polyurethane foam material while in contact with the planar surfaces of the upper and lower plate members will cause the formation of planar panel surfaces that efficiently define the exterior and interior wall surfaces of a building. Further expansion of the polyurethane foam material will cause it to flow or be forced into even the smallest voids within the panel framework and to develop an internal foam pressure that enhances the structural integrity of the foam body and also significantly enhances the structural integrity of the pre-fabricated panels. Care is taken during injection of the polymer foam material to ensure that the quantity of A and B constituents is optimum for accomplishing complete filling of the interior of the panel framework and for developing desired foam pressure as the result of foam expansion.

[0055] After a predetermined period of time the polymer foam will have become sufficiently cured that its expansion will have become completed and stabilized. At this point the support plate and the expansion resisting upper plate will be separated thus permitting the substantially complete pre-fabricated insulated panel to be removed from the machine or press for transportation to a panel collection and storage site for complete curing of the polyurethane foam material. Thereafter, completed pre-fabricated insulated panels can be loaded onto a truck, train or the like and transported to a construction site for use in the construction of a building. The completed pre-fabricated panels are of relatively lightweight construction and thus even the largest pre-fabricated panels can be manually lifted and handled by a few workers, typically without the need for any mechanized lifting and handling equipment. At a construction site, however, it may be desirable to provide lifting and handling equipment so that a worker may remove panels from a truck and move them to specific locations at the job-site. The wall, ceiling and roof panels are typically provided with an identification designation in coordination with the plans for the building that is to be constructed. This enables workers to move the panels to their site of intended use, so that the construction project can be accomplished efficiently.

[0056] Building construction is accomplished by first installing a building foundation, typically a concrete slab foundation, with metal mounting members projecting from the cured concrete of the foundation. Corresponding mounting members, such as mounting flanges or mounting tabs, project from the bottom structural member of the prefabricated building panels. The pre-fabricated insulated
building panels are raised to vertical position and supported while the mounting flanges or mounting tabs are connected to the metal mounting members. Installation of the wall and roof structures of a typical residential dwelling can be accomplished in one or two days time.

[0057] The upper plate member may be mounted for vertical movement by a plurality of linear motors such as air or hydraulic cylinders, electric motors or the like and may be weighted to provide resistance to the expanding polymer foam material within the metal panel framework. The lower plate member may be supported for substantially horizontal movement so that a metal panel framework can be placed on the lower plate member. The flat support plate member with the exterior portion of the panel framework resting on it is then moved horizontally to a position beneath the upper plate member. This horizontal or lateral movement of the lower support plate member can be accomplished manually or can be mechanized, such as by supporting the lower support plate on wheels that are guided along tracks during movement. With the metal panel framework so positioned, the upper plate member can then be lowered to establish foam expansion resistance contact with the metal panel framework. The weight of the upper resistance panel member and its support structure will confine the expanding polymer foam to the voids of the panel framework and the upper resistance plate member will establish a substantially planar panel surface that is co-planar with the framework surfaces. The polyurethane foam material will expand and completely fill the voids of a panel framework and will then generate an internal pressure within the framework that forces the foam material into even the smallest interstices of the framework voids. This internal panel pressure also functions to enhance the density of the body of foam material within the framework and thus enhances the structural integrity of the foam and thus the structural integrity of the resulting insulated structural panel. The internal pressure during polymerization of the polyurethane foam ensures complete filling of the insulated structural panel and thus eliminates any voids that might define a path for the propagation of fire within a panel.

[0058] The thermal insulating capability (R factor) of the pre-fabricated insulated building panels may be controlled, if desired, by mounting one or more polyurethane foam displacement members to the upper resistance plate member or to the lower support plate member. As the polyurethane foam material is injected into the voids of the panel framework structure, these displacement members will control the volume of the foam material that can be formed within the voids of the framework during polymerization expansion of the polyurethane foam material. The displacement members will thus also control the thermal insulating capability (R factor) of the resulting pre-fabricated panels and minimize the manufacturing cost of the panels by controlling the volume of polyurethane foam that is present within the panels.

[0059] Typically, polyurethane foam material is displaced from the interior portions of the pre-fabricated panels and between the panel wall studs, providing the panels with a waﬄe-like appearance. The resulting depresions in the interior surface of the panels will not be objectionable since during building construction the interior wall surfaces of the panels will be covered by wallboard or by other paneling materials. However, if desired the exterior portions of the polymer foam material may be displaced or both the interior and exterior portions of the polymer foam material may be displaced if desired to control the thickness and thus control the thermal insulating characteristics of the polymer foam insulating material of the resulting pre-fabricated insulated wall panels.

[0060] Referring now to FIGS. 7-9, a mechanism for manufacturing insulated wall panels for use in the construction of buildings is shown generally at 50. A generally rectangular machine support frame is shown generally at 52 and includes a plurality of generally vertically oriented support posts, two of which are shown at 54 and 56. The machine support frame 52 is also comprised of a pair of horizontally oriented structural members 58 and 60 that are fixed to the upper ends of the vertically oriented support posts, such as by welding or by means of mounting bolts. Transverse structural members 62 are connected to each of the horizontally oriented structural members 58 and 60 such as by welding. The support posts, horizontally oriented structural members and transverse structural members are shown as being of circular cross-section, but its is to be understood that they may be of square or rectangular cross-sectional configuration or any other configuration without departing from the spirit and scope of the present invention.

[0061] Spaced, generally parallel, guide rails or tracks 64 and 66 are fixed to the upper portions of the longitudinally oriented structural members 58 and 60 such as by welding, and if desired may be defined by simple angle structures oriented with the apex of the intersecting flanges thereof facing upwardly. The guide rails or tracks may also be defined by channel members or may have any other suitable configuration that provides a substantially horizontal guiding function for reciprocating linear movement of a lower panel frame support plate member 68 for transporting a wall panel frame 10 to position it beneath an upper expansion resistance or foam confinement plate member 70. Guide wheel assemblies 71 are mounted to the lower portion of the lower panel frame support plate member 68 and include guide wheels 72 that establish guiding relation with the spaced, generally parallel guide rails or tracks 64 and 66.

[0062] Stabilization of the generally rectangular machine support frame with respect to a substantially horizontal surface of a manufacturing facility floor or the like is achieved by means of screw jacks 57 that are fixed to the lower ends of the support posts 54-56. Leveling and stabilization of the generally rectangular machine support frame may also be accomplished in any other suitable manner, such as by adding shims to the lower ends of the support posts. The downward force of the upper expansion resistance or foam confinement plate member 70 may be adjusted from time to time simply by exchanging larger of smaller l-beam members for those shown in FIG. 8 or by adding one or more l-beam weight members to the upper expansion resistance or foam confinement plate member 70 between the l-beam weight members that are shown. It should be borne in mind that the weight members may be of any other suitable character if desired and need not be physically attached to the upper foam resistance plate member since their purpose is to add weight to the upper plate member and minimize the potential for bending of the upper plate member by the internal pressure that is developed during polymerization expansion of the polyurethane foam material.
Though the upper and lower plate members can be moved relative to one another, it is preferable to maintain a static position of the lower support plate member during injection and polymerization expansion of the polyurethane foam material and to selectively move the upper expansion resistance or foam confinement plate member 70 upwardly and downwardly during the pre-fabricated panel manufacturing process. By filling the voids of the panel framework with polymer foam material and controlling its expansion during polymerization to define at least one substantially flat finished panel wall surface. As is evident particularly from the end elevational view of FIG. 8, lift support members, two being shown at 76 and 78 are mounted to the machine support frame 52. The lift support members each have a generally vertically oriented support post 80 and a generally horizontally oriented support shoulder member 82 which is welded or otherwise fixed to the support posts 54 or 56. The support shoulder member 82 defines a generally horizontal upwardly facing shoulder surface 84 on which is supported a lift motor 86. As mentioned above, the lift motor 86 is preferably a compressed air energized cylinder and piston assembly which employs compressed air from the compressed air supply that is typically provided in manufacturing facilities to cause force applying extension of a motor output shaft 88. In the alternative, the lift motor may be a hydraulically energized linear motor or an electrically driven linear motor. The lift support members 76 and 78 are also preferably provided with angulated brace members 90 that are welded or otherwise fixed to the lift support members and the vertically oriented posts 54 and 56 of the generally rectangular machine support frame 52. The angulated brace members function to transfer the forces of the linear lift motors to the vertically oriented posts 54 and 56. Adjustable motor mount members 92 are driven by the output shafts of the linear motors and provide for adjustable support of the upper expansion resistance or foam confinement plate member 70, so that a precisely parallel relationship can be established between the plate members 68 and 70 for establishment of precisely parallel interior and exterior surfaces of the resulting pre-fabricated insulated wall, ceiling and roof panels.

It is desirable that the upper expansion resistance or foam confinement plate member 70 be capable of engaging a wall or roof panel framework, 10 with considerable downwardly directed force so that expansion of the polymer foam material within the voids of the panel framework and will not force the plate member 70 away from the panel framework and thus cause the surface of the finished insulated wall or roof panel to have a configuration other than planar. This feature is deemed necessary since the polymerizing foam material can generate substantial pressure responsive force during its expansion. This foam induced pressure is desirable since it enhances the density of the resulting polyurethane foam body and thus enhances the structural integrity of the resulting pre-fabricated panel. However, the foam induced pressure should not become sufficiently great to cause bending or other distortion of the upper and lower plate members or to rupture or distort the panel frame structure. One suitable means for causing the development of a desired downwardly directed force of the upper foam expansion resistance or confinement plate member 70 is accomplished by mounting heavy metal l-beam members 94 and 92 to the upper surface of the plate member as shown in FIGS. 7 and 8. Assuming the plate members 68 and 70 are composed of steel having a thickness in the range of from about ¼ inch to about 1 and ½ inches, the polymer foam material can generate an expansion force that may be sufficient to causing flexing of the plate members, particularly the upper plate member, since the lower plate member is supported on the guide tracks by the support and guide wheel assemblies 71. The heavy l-beam members 94 and 96 provide structural resistance to flexing or bending of the upper plate member by the force developed by the polymer foam material during its polymerization expansion. It should be borne in mind that other types of weight applying members may be employed instead of the l-beam members if desired. A desired number of weight members may be placed at desired locations on the upper expansion resistance or foam confinement plate member 70 to counteract or control any tendency of the plate member to be flexed or otherwise distorted by the force of the expanding and confined polymer foam material.

A lift actuation system is shown generally at 100 in FIG. 8 for actuating the plurality of lift motors 86, thus raising the upper foam expansion resistance or confinement plate member 70 and its weight member or members. The lift actuation system incorporates a motor control housing 102, which is mounted to transverse support elements 104 that are fixed to the vertical support posts 54 and 56. Assuming the lift motors 86 are linear air motors or cylinder and piston actuators, lift actuation system 100 incorporates an air supply and lift control system 106 for simultaneously actuating the plurality of lift motors is housed within the motor control housing 102. An air supply manifold conduit 108, which may be in the form of a simple flexible air supply hose, is in air supplying communication with each of the air cylinder lift motors 86. An air supply conduit 110 is in controlled communication with a source of compressed air, such as the air supply system of a commercial manufacturing building. A motor control actuator 112 may be mounted to the motor control housing 102 and may be selectively actuated for raising and lowering of the upper foam expansion resistance or confinement plate member 70 and its weight member or members. Alternatively, the motor control actuator 112 may be mounted to a machine operation control member that is connected with other machine control components by means of a flexible control cable so that operating personnel can operate the polymer foam filling mechanism from any nearby remote position.

During the manufacturing process, with the lower panel frame support plate member 68 located at a loading position shown in FIG. 7 a wall panel framework 10 is positioned on the lower support plate member 68. The linear motors 86 are then selectively energized, raising the upper foam expansion resistance or confinement plate member 70 to a desired position above the level of the upper surface of the panel framework. The lower panel frame support plate member 68 is then moved latently to a desired position beneath the upper plate member 70. This lateral movement may be accomplished mechanically, such as by means of a linear actuator device or may be accomplished manually, simply by applying a pushing force to the lower support plate member 68 to move it along the guide rails or tracks 64 and 66. After the lower plate member 68 and a wall, ceiling or roof panel framework supported thereof have been moved to a position beneath the upper plate member, the linear motors are simultaneously actuated or de-energized, permitting the upper plate member 70 to be lowered into
force transmitting contact with the upper portion of the panel framework. When the upper plate member 70 is in contact with the upper portion of a wall panel framework, the interior of the panel framework will essentially be closed or confined.

[0067] At this point it should be noted that the exterior and interior structural members of the panel framework are provided with injection gun holes 114 as shown in FIG. 2 that permit a plurality of foam injection gun tubes to be inserted into the internal voids of the panel framework and extended substantially the entire internal length of the panel framework. As the polymer foam material is injected into the framework voids at a predetermined rate depending on the size of the insulated wall panel, the injection gun tubes are withdrawn at a controlled rate so that the mixed by un-cured polymer foam material is evenly distributed within the voids of the panel framework. Since the un-cured A and B polymer foam mixture is evenly distributed, as the composition expands during its polymerization, the expanding polymer foam will not tend to become concentrated at any region within the confined space of the panel framework. Thus its expansion will not tend to be excessive in any portion of the framework and the force that it can apply to any panel framework component and to the upper and lower plate members 70 and 68 will be minimal.

[0068] During its expansion the polymer foam material will come into contact with the support and resistance plate members and thus will establish substantially planar polymer foam panel surfaces due to its confinement within the panel framework by the plate members. By confining the polymer foam material within the panel framework during its expansion by the significant restraining capability of the upper and lower plate members, the expanding foam material, seeking the path of least resistance, will flow or expand into even the smallest internal voids of the panel framework. Thus, the polymer foam material will substantially completely fill the internal voids of the hollow, sheet metal structural members, establishing a unique mechanically interlocking relationship between the resulting body of polymer foam material and the various structural members of the panel framework as shown in FIGS. 2 and 3. This feature adds significant structural integrity to the resulting insulated wall construction panels, so that the strength of a building constructed by assembling a number of the prefabricated insulated wall panels of this invention will significantly exceed the wind resistance strength of similar walls constructed of wood components. The resulting planar wall surfaces of the polymer foam material will be substantially co-planar or coextensive with the internal and external flanges 42 and 44 of the side, top and bottom structural members that define the perimeter of the insulated panel structure.

[0069] Though the insulated wall panels of the present invention may be completely filled with polymer foam material to provide the highest possible thermal insulation characteristics, or R-factor for a particular wall thickness, in many cases it is desirable to control the thickness of the polymer foam insulating core of the panels and thus provide regions of less that full panel thickness within the insulated construction panels. Control of the thickness of the polymer foam insulating core is done to minimize the amount of polymer foam material that is present in the panels or to establish an R-factor of the panels that is appropriate to the weather or environmental conditions within which the building structure is to be located. One suitable method for controlling the thickness of the polymer foam is shown in FIGS. 3, 7 and 8. Polymer foam displacement elements 116, 118 and 120 are fixed to the lower surface of the upper foam expansion resistance or confinement plate member 70 and are spaced according to the spacing of the various structural members of a particular wall panel framework 10. When the upper foam expansion resistance or confinement plate member 70 is in force applying contact with the upper portion of a panel framework structure, the polymer foam displacement elements will project downwardly into some of the voids of the panel framework structure. Thus, the volume of A and B polymer foam constituent mixture is reduced according to the combined dimension of the displacement elements. After the polymer foam has become expanded and cured to the point that its dimension will have become stabilized, the upper plate member 70 is moved upwardly to the point that it is separated from the upper portion of the wall panel framework structure and the foam displacement elements will have been extracted from the voids and moved to a level above the panel framework structure. This activity will leave pockets or recesses, such as shown at 122, 124 and 126 in FIG. 3, within the body of foam material of the completed insulated wall panels. After panel assembly to form the walls of a building structure, wallboard or other suitable interior wall covering material is fixed to the insulated wall panel structure in a manner covering the depressions or pockets. If appropriate, the polymer foam displacement elements 116, 118 and 120 may be provided with exterior draft to ensure that the foam displacement elements are easily separated from the polymer foam material.

[0070] With reference now to FIGS. 10-19, various wall panel structures are designed for use in the construction of a building from a plurality of fabricated insulated panels. As shown in the elevational view of FIG. 10, a wall panel shown generally at 128 is of the same general construction as shown in FIG. 1 and additionally employs intermediate wall studs 130 and 132. An electrical service box 134 and conduit 136 are shown to be embedded within the polyurethane foam material of the panel structure. The electrical box 134 is fixed to a structural wall stud member 130 and provides wiring for electrical service, telephone service or television cable. In FIG. 11, the elevational view illustrates a wall panel 138 having intermediate wall studs 140 and 142. A plurality of electrical boxes 144, 146 and 148 are mounted to the metal stud and panel perimeter members. The wall panel structure 150 of FIG. 12 incorporates the same perimeter structural members as shown in FIG. 1 and additionally has transverse structural members 152 and 154 and vertical window frame elements 156 and 158 that cooperatively define a window opening 160 within which a window assembly is to be mounted. The panel framework is strengthened by intermediate metal wall stud sections 162, 164, 166 and 168.

[0071] Another wall panel construction is shown generally at 170 in FIG. 13 having a horizontal door frame member 172 and vertical door frame stud sections 174 and 176 that cooperatively define a door opening 178 within which a door assembly is to be mounted. Electrical service boxes 180 and electrical conduits 182 are mounted to the metal structural members of the panel and are encapsulated by polyurethane foam material that is injected into the voids of the panel
framework. Another door panel construction is shown generally at 18 in FIG. 14 which is similar to that of FIG. 13, with the structural components thereof being identified by like reference numerals. Electrical service boxes 184 and electrical conduits 186 are mounted to structural members of the panel framework and are encapsulated by the polyurethane foam material that fills the voids of the framework. The electrical conductors of the insulated wall panels are connected in junction boxes that are mounted to the upper portions of the joined wall panels or are mounted to the ceiling joists of the resulting building structure.

[0072] FIG. 15 illustrates an insulated wall panel shown generally at 188 which is of similar construction as shown in FIG. 10, with spaced internal wall stud members 190 and 192 of the panel framework providing support for an electrical service box 194 and a television cable box 196. A telephone service box 198 is simply maintained in desired position by being encapsulated with the polyurethane foam material that fills the voids of the panel framework structure. Another pre-fabricated insulated door panel is shown generally at 200 in FIG. 16 and has transverse structural members 202 and 204 and vertical structural members 206 and 208 that cooperatively define a window opening 210 within which a window assembly is to be mounted. Another window panel is shown generally at 212 in FIG. 17 which differs from that of FIG. 16 in the location of service boxes 214 and 216 on wall stud sections 218 and 220. The service boxes and their electrical conduits are of course encapsulated within the polyurethane material that fills the voids of the panel framework structure. The panel framework structure defines a window opening 222 within which a window assembly is installed after the wall panel has been assembled with other wall panels to form a building wall structure.

[0073] The plan view of FIG. 18 has parts thereof broken away and illustrates a roof panel shown generally at 224 having lateral perimeter structural members 226 and 228 and end structural members 230 and 232. Longitudinal intermediate structural members 234 and 236 are evenly spaced between the perimeter structural members 226 and 228, with the ends thereof being fixed to the end structural members 230 and 232. Other transverse structural members 238 and 240 are fixed to the lateral perimeter structural members 226 and 228 and to the longitudinal intermediate structural members 234 and 236 to provide for strengthening of the end portions of the roof panel. As shown particularly in the side elevational view of FIG. 19, the panel structure defines tapered ends 242 and 244 that are tapered according to the roof pitch design of the intended building structure. Though the dimension of the roof panel will vary according to the intended roof dimension, a roof panel designed for a residential dwelling has been designed with a length of about 26"x60" and a width of about 4' 0". The roof joists may have a dimension similar to that of a conventional 2"x4" structural member or if desired may have a maximum dimension about the same as a conventional 2"x6" structural member. These dimension are intended solely to indicate that the roofpanels may be of considerable length and may vary in thickness according to the character of the roof that is intended. When the roof panels are installed intermediate structural bracing is employed to ensure the desired load carrying capacity and structural integrity of the roof structure of a building. The roof structure may be finished by application of a wide variety of roofing materials to the upper surfaces of the roof panels; however a sound and serviceable roof will be established when standing seam metal roofing is employed. As mentioned above, the upper surface of a roof structure may be finished with conventional roofing materials such as asphalt or fiberglass shingles or may be provided with metal roofing, such as coated steel or aluminum. It has been determined that standing rib steel roofing provides the roof structure of a building with a service life of about 40 years. The metal roofing panels provide for efficient reflection of the heat of the sun and thus assist in enhancing the thermal insulating characteristics of a roof system composed of the pre-fabricated insulated structural panels of the present invention.

[0074] It is desirable during construction of a building using the polyurethane structural insulated panels of the present invention, to thoroughly anchor the wall structures to the foundation, typically a concrete slab foundation. Proper anchoring of the exterior walls of a building to the foundation is critically important for resistance to wind damage from storms such as thunderstorms, hurricanes and tornados. Where concrete slab foundations are used, typically wood structural members are attached to the upper surface of the foundation by driving concrete anchor fasteners through the wood members and into the foundation by using a carbide powered nail gun. However, the wood foundation members are exposed to moisture seeping through the foundation and to insects that may have access to the structural members via the weep holes in the brick veneer or via cracks that may develop in the concrete of the foundation. Excess moisture and insects, such as termites, will cause rapid deterioration and damage to the lower wood members of conventional wall structures. Also, termites, once gaining access to the lower wood members or sills, will migrate to other wood members of a framework. This deterioration and damage to the wood structural members weakens the resistance of the building to wind damage.

[0075] As shown in FIGS. 20 and 21, anchor members shown generally at 250, are fixed to a concrete foundation 251. The anchor members 250 for typical residential buildings employ a ¾" steel anchor plates 252 having a dimension of about 6"x6" and are embedded within the concrete of the slab foundation at spaced locations of approximately 4' on center. The anchor plates 252 may be of any other selected rectangular dimension and may be of any other selected thickness as desired. A plurality of hook-like anchors 253, 254 and 256 project downwardly from the lower surface portion of the steel anchor plates 250. The hook-like anchors are preferably formed from lengths of concrete reinforcing bar material, "re-bar", that are fixed to the steel anchor plates by welding, as shown at 257 or by any other means of attachment. The reinforcing bar material is preferably ¾" re-bar for residential dwellings, but may be of any suitable dimension for adequately securing the anchor plates to the concrete of a foundation. The lower ends 258, 260 and 262 of the hook-like anchor members are simply formed by bending end portions of the anchor members to extend laterally, as shown in the side elevational view of FIG. 21.

[0076] When a concrete foundation is poured, and before the concrete has become set, the anchor members 250 are accurately positioned for wall location and are embedded within the wet concrete so that the upper surface of the anchor plates is substantially co-extensive with the upper surface of the concrete. The anchor members 250 are then vibrated or otherwise moved to cause the wet concrete to
establish intimate contact with the lower portion of the steel anchor plates and with the depending re-bar hook-like anchors. After ensuring accurate location of each of the anchor members, the concrete is permitted to become set, thus securing the anchor members in anchored relation with the foundation. Anchor screws, bolts or other suitable fasteners are then employed to secure the central web of a U-shaped wall mounting track shown generally at the anchor plates. Various lengths of the wall mounting track extend along the perimeter of the concrete foundation and thus define a wall mounting perimeter of the foundation and is fixed to two or more of the spaced anchor members. The wall mounting track is preferably formed by bending 20 gauge galvanized sheet metal, and defines spaced, parallel upstanding wall mounting flanges and between which the lower end of a structural insulated wall panel is located. Mounting screws extend through the upstanding wall mounting flanges and and the lower portion of the pre-fabricated structural insulated wall panel within the wall mounting track. The position of the lower edge portion of the structural insulated panel can be adjusted as needed and the mounting screws are then driven through the flanges to secure the wall panel at the selected position.

In view of the foregoing it is evident that the present invention is one well adapted to attain all of the objects and features hereinabove set forth, together with other objects and features which are inherent in the apparatus disclosed herein.

As will be readily apparent to those skilled in the art, the present invention may easily be produced in other specific forms without departing from its spirit or essential characteristics. The present embodiment is, therefore, to be considered as merely illustrative and not restrictive, the scope of the invention being indicated by the claims rather than the foregoing description, and all changes which come within the meaning and range of equivalence of the claims are therefore intended to be embraced therein.

I claim:

1. A pre-manufactured insulated construction panel system for use in the construction of buildings, comprising:
   a panel framework having substantially straight perimeter framework members defining side, top and bottom perimeters of said panel framework and being composed of sheet metal bent to define a generally U-shaped cross-sectional configuration and having a central web and substantially parallel exterior and interior flanges being integral therewith;
   longitudinal and transverse structural members being connected with said substantially straight perimeter framework members;
   at least one of said substantially straight perimeter framework members and at least one of said longitudinal and transverse structural members defining liquid injection holes; and
   a body of cured in-situ polyurethane foam material filling substantially all of said internal voids of said panel framework and defining a substantially planar exterior wall surface, said body of polymer foam material being formed by mixing and injecting A and B polymer foam constituents into said internal voids of said panel framework and by confining said polyurethane foam material to said internal voids during polymerization expansion thereof.

2. The pre-manufactured insulated construction panel system of claim 1, comprising:
   one of said substantially straight perimeter framework members being angulated in correspondence with the pitch of a roof structure of a building constructed by assembly of a plurality of said pre-manufactured insulated wall panels.

3. The pre-manufactured insulated construction panel system of claim 1, comprising:
   said substantially straight perimeter framework members each having a central web and interior and exterior flanges being in substantially parallel relation and being integral with said central web.

4. The pre-manufactured insulated construction panel system of claim 3, comprising:
   edge flanges being integral with said interior and exterior flanges and being oriented in substantially normal relation with said interior and exterior flanges and being disposed in substantially co-planar opposed relation and defining a slot extending the length of said substantially straight perimeter framework member and defining an opening through which expanding polymer foam is admitted into said substantially straight perimeter framework members.

5. The pre-manufactured insulated construction panel system of claim 1, comprising:
   at least one electrical service box being mounted to one of said structural members and an electrical service conduit being embedded within said body of polymer foam material.

6. The pre-manufactured insulated construction panel system of claim 1, comprising:
   said substantially straight perimeter framework members having a central web defining a panel thickness; and
   at least one recess being defined within said body of polymer foam material and establishing a polymer foam thickness less than said panel thickness and establishing an insulation R-factor of at least a portion of said body of polymer foam material.

7. The pre-manufactured insulated construction panel system of claim 1, comprising:
   said substantially straight perimeter framework members defining window and door openings which window and door assemblies are mounted to close and finish a building wall structure.

8. The pre-manufactured insulated construction panel system of claim 1, comprising:
   said panel framework defining at least one opening within which is mounted a window or door assembly.

9. The pre-manufactured insulated construction panel system of claim 1, comprising:
   a plurality of anchor member adapted for spaced location on a concrete foundation and adapted to be at least partially embedded within the concrete of a concrete foundation, said anchor members each having an anchor plate and a plurality of anchor elements being
fixed to said anchor plate and projecting downwardly for anchoring within the concrete; and

a wall mounting track being mounted to said anchor plate and having spaced upstanding mounting flanges; and

a plurality of fasteners extending through said anchor flanges and engaging within said pre-manufactured insulated construction panel and securing said pre-manufactured insulated construction panel system to the foundation via said anchor members.

10. A mechanism for substantially completely filling an insulated construction panel framework with a body of cured in-situ polymer foam material, comprising:

a machine frame;

a lower support plate member being supported by said machine frame;

an upper polymer expansion confinement plate member being supported by said machine frame;

said upper polymer foam expansion confinement plate member and said lower support plate member being disposed in substantially parallel relation and being relatively moveable to a release position permitting a construction panel framework to be positioned between said upper and lower plate members and to be removed from between said upper and lower plate members and a clamping position with said upper polymer foam expansion confinement plate member and said lower support plate member in engaging relation with a construction panel framework; and

a mechanism selectively causing relative movement of said upper polymer foam expansion confinement plate member to said release position and said clamping position.

11. The mechanism of claim 10, comprising:

said lower plate member being linearly moveable to a construction panel framework clamping position beneath said upper plate member and a construction panel framework loading position laterally of said upper plate member.

12. The mechanism of claim 11, comprising:

at least one guide track being mounted to said machine frame; and

guide members being mounted to said lower plate member and being linearly moveable on said guide track, said guide members permitting guided linear movement of said lower support plate member to said loading position and said clamping position.

13. The mechanism of claim 10, comprising:

at least one lift member being mounted to said machine frame and establishing force transmitting relation with said upper plate member, said lift member being selectively actuated for moving said upper polymer foam expansion confinement plate member upwardly to said release position.

14. The mechanism of claim 10, comprising:

said at least one lift member being a plurality of lift members being energized for moving said upper polymer foam expansion confinement plate member upwardly to said release position while maintaining said upper plate member substantially parallel with said lower support plate member; and

a lift actuator being connected for simultaneous energization of said plurality of lift members; and

said upper polymer foam expansion confinement plate member having a weight sufficient for engagement of a construction panel framework with sufficient force to confine said polymer foam material to voids within said construction panel framework and to resist expansion of said polymer foam material beyond spaced substantially parallel planes defined by a construction panel framework, said upper polymer foam expansion confinement plate member and said lower support plate member establishing substantially planar substantially parallel polymer foam panel surfaces of a construction panel.

15. The mechanism of claim 14, comprising:

structural members being disposed in engagement with said upper polymer foam expansion confinement plate member and preventing bending of said upper polymer foam expansion confinement plate member by pressure developed during polymerization expansion of said polymer foam material.

16. The mechanism of claim 10, comprising:

at least one polymer foam displacement element depending from said upper polymer foam expansion confinement plate member and controlling the thickness of polymer foam within the construction panel framework according to desired thermal insulation characteristics.

17. A method for manufacturing insulated construction panels for use in the construction of walls, ceilings and roofs of buildings, comprising:

providing a construction panel framework having perimeter structural members and internal structural members defining internal panel voids and defining panel flanges disposed in opposed spaced planes and having polymer foam injection openings in said perimeter structural members;

locating said construction panel framework on a lower support plate member;

establishing clamping force of said lower support plate member and an upper polymer foam expansion confinement plate member with said construction panel framework;

mixing A and B constituents of a polymer foam material and injecting the mixture in evenly distributed manner within said internal panel voids; and

with said lower support plate member and said upper polymer foam expansion confinement plate member confining polymerization expansion of said polymer foam material to said internal voids of said construction panel framework and defining substantially planar and substantially parallel polymer foam construction panel surfaces.

18. The method of claim 17, comprising:

positioning said lower support plate member at a panel framework loading position laterally of said upper polymer foam expansion confinement plate member;
positioning a panel framework on said lower support plate member;

moving said lower support plate member and said panel framework laterally to a panel framework clamping position;

causing relative movement of said lower support plate member and said upper polymer foam expansion confinement plate member to positions clamping the panel framework therebetween and causing confinement of the internal voids of the construction panel framework;

maintaining the clamping force of said lower support plate member and said upper polymer foam expansion confinement plate member during sufficient polymerization of said polymer foam material for dimensional stabilization thereof;

separating said lower support plate member and said upper polymer foam expansion confinement plate member; and

moving said lower support plate member laterally to said loading position.

19. The method of claim 17, comprising:

controlling injection of said mixture of said A and B constituents through said openings and into said voids of said construction panel framework at a measured volume that creates a polymer foam pressure during polymerization expansion that forces the expanding polymer foam into substantially all of the internal voids of a construction panel framework and causes increased density of the resulting polymer foam body for enhancement of thermal insulating characteristics and structural integrity thereof.

20. The method of claim 17, comprising:

positioning at least one polymer foam displacement element within said construction panel framework for controlling the thickness of the resulting polymer foam body and thus controlling the thermal insulation characteristics of the resulting polymer foam body.