PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

No. 2471 A.D. 1945.

Improvements in and relating to Building Units and Building Construction.

We, PERCY FRED BELL, of 20, Sandy Way, Walton-on-Thames, Surrey, a British subject, NORMAN GREENLEES WEIR LOUDON, of Littleton Park, Shepperton, Middlesex, British subject, and SOUND CITY (FILMS) LIMITED, of Sound City, Shepperton, Middlesex, a British Company, do hereby declare the nature of this invention to be as follows :—

This invention relates to the manufacture of building units and to building construction for dwelling houses or similar buildings.

Present-day requirements and conditions brought about by war have created very difficult housing problems both with regard to labour and materials.

The present invention is directed to a solution of these problems while allowing freedom of design and latitude with regard to accommodation, and the aim of the invention is to provide building units in which metal and wood (rendered scarce by the state of war) are absent or reduced to a minimum, and which may be both factory manufactured or prefabricated and speedily erected by the use of unskilled or partially skilled labour.

The invention also affords the advantages that electric wiring and service conduits or piping may be readily introduced and accommodated in the improved units at suitable stages during erection, and that due to the nature and structure of the units material sound and heat insulation is afforded.

The invention consists in a building unit of cement, fibrous or other plaster, or any non-metal mouldable material or composition (hereinafter referred to as plaster) comprising a pair of spaced parallel wall or surface forming areas (hereinafter called wall areas) integrally united by a transverse cellular core (the axes of the cells being at right-angles to the wall or surface planes) co-extensive with the wall areas, both the wall areas and the cell structure being reinforced by fabric such as that known as scrim and hereinafter referred to as such.

The cellular structure is kindred to the well-known honeycomb form, the cells being hexagonal but preferably having a pair of opposite walls shorter than the others.

The invention also consists in a method of prefabricating units of the character indicated above including two steps: the first being the moulding of the scrim reinforced cellular core, which in axial extent may be formed according to the thickness of the building units (or in multiples thereof and subsequently subdivided at right-angles to the cell axes to afford the desired widths), while the second step comprises erecting a cellular core endwise in a layer of scrim reinforced wall area plaster supported on a mould platform so that the ends of the cells are integrally incorporated in the wall plaster, and then inverting the core and attached wall upon a similar layer of plaster to form the opposite wall area of the building unit.

The method step first-mentioned may comprise applying (preferably by brushing) plaster upon a web of scrim supported in a series of ridge and trough moulds or forms for one half of the cells of a row, erecting collapsible ridge forms (formed of a pair of leaves hinged together lengthwise) over the first troughs, laying a web of scrim upon the collapsible forms and in the troughs between, plastering the scrim to form the other half of the cells of the row, withdrawing the collapsible forms axially (after having partially folded the hinged leaves together) and then proceeding with duplication moulding to complete the extent of structure desired by re-erecting the hinged ridge forms successively over the troughs as the cells are built up.

The number of superposed cells depends upon the predetermined width of the building units or the number of cell units to be assembled or fitted together and moulded between the wall areas for a building unit.

It will be appreciated that, according to

the invention, the edges of the building units expose half or fragments of the cell cavities and these are utilised in connecting units together either in direct line or at an angle to one another for corners or wall or partition junctions.

The junction of units is effected by drilling or otherwise forming small holes (which are subsequently filled) in the wall areas adjacent a joint and pouring or extruding semi-liquid plaster through the holes to fill the adjoining fragmentary cell cavities and clearances so that the introduced plaster forms uniting keys. The joint may be reinforced by the previous insertion and temporary plastering of scrim "dollies" (made of rolled pieces or tags of scrim) in adjoining unit cavities which eventually become embedded in the jointing plaster.

As erection proceeds electric wiring and conduits or piping for services may be inserted by, in the case of wiring, perforating the cell walls laterally (between the wall areas) with a pointed rod provided with an eye or hook to which the wires are attached. Pipes may be introduced by thrusting them lengthwise to puncture the said cell walls.

The cellular structure of the building units may be left empty, or they may be filled in the second moulding stage with sawdust or other appropriate comminuted or fibrous sound or heat insulating material which may be impregnated with an agent to render such fire-resisting, or the filling may be of a natural fire-resisting character.

To increase the load carrying capacity of the units (either in the prefabrication stage or in erection) concrete (reinforced or otherwise) may be moulded at the edges of units or at corner junctions or between units, the exposed cell cavities of the units serving as keys for the moulded concrete.

The wall areas of a unit may be of the same nature on both sides, that is to say both may be, for example, of a fibrous plaster or one area, say for the interior side, may be of fibrous plaster and an external wall area may be provided by moulding the said wall layer in a cement-sand or concrete mixture.

In carrying the invention into effect according to one mode as described, by way of example, as applied to the production of a standard building unit, moulding means are made for forming the cellular core and moulding platforms constructed for producing the wall areas. The core moulding means may be formed in wood or metal and comprise a series of ridges (of inverted V form with flat apexes) which are arranged parallel and spaced apart to form corresponding troughs or valleys, the sectional contour of the ridge and trough form being that of one half of the cells of a row. The floor of a trough is flat and corresponds in width with that chosen for one of the shorter sides of the hexagonal shape. The series of troughs and ridges may extend for any suitable length but it is convenient to form such in lengths corresponding with the height of a building unit or a multiple thereof so that the longer lengths can be readily cut into the standard lengths for the units. The lengths (or axial extent) of the ridges and troughs again may be as convenient and may be multiples of the thickness of the cellular core which it is intended to embody between wall areas as the cellular structure when moulded may be cut at right-angles to the troughs and ridges into suitable widths.

At the ends of each trough a closure piece is temporarily erected which corresponds with the shape of the contour of a trough and extends upwardly to an apex at an angle corresponding with the other half of the cell shape. These end closure pieces have slightly above their widest dimension a pair of small ledge pieces provided which constitute footings for hinged ridge forms adapted to be located for the commencement of a second and subsequent rows of cells. The hinged forms comprise a pair of leaves hinged together to provide collapsible ridge-forming members, and may be of wood or metal. Where wood is employed it is preferable to provide them with a covering of American cloth or other protective layer which will prevent sticking of the plaster. In the region of the hinge the leaves are formed so that when in the erected position their edges are adapted to provide shorter cell walls parallel with those of the trough floors of the first-mentioned or base mould form.

In operation, a web of scrim is laid over the ridges and in the valleys of the base mould form, the scrim being held down on the floor of the troughs by loose battens. The end pieces are placed in position to close the ends of the troughs and in the first step these end pieces serve simply to confine the plaster laterally in the moulding operation. Fibrous plaster is applied in the form of a thick paste by brushing it onto the scrim throughout the length of the mould form. After this has set the battens are removed from the troughs and the collapsible hinged ridge forms are erected on the footings on the end pieces of the troughs. The troughs between the collapsible ridge forms are filled by other end pieces similar to those already described for the base form. The erection of these hinged ridge forms provides a ridge and trough contour similar to that of the base mould form and a web of scrim is laid over these ridges and in the troughs between them, being held down in the troughs by repositioning the battens referred to above. Plaster is brushed onto the scrim and when it has set the collapsible

ridges are freed from the plaster by tapping and then are folded together and withdrawn axially after the trough end pieces have been removed.

The collapsible ridge forms having been removed, these are re-erected on the footings of the second and subsequent rows of end pieces and moulding proceeds row by row until a tier of cells has been formed of a suitable height for providing a core corresponding in width with the standard width adopted for the building unit, although it will be appreciated that a building unit may be formed of a number of core units placed together in adjoining relationship to make up the width of the unit desired.

When the cellular core formed in the above manner is properly set it is removed from the base mould form, which supports it, and cut at right-angles to the axes of the cells according to the thickness predetermined for the standard building unit.

These cut sections are next faced on each side with plaster wall areas and this operation is carried out on moulding platforms as referred to above. These moulding platforms may be perfectly plain when the exterior surface of the standard unit is to be of that character, or they may be recessed or provided with ridge mouldings to produce corresponding moulded forms on the exterior surfaces of the units, such as for example to form skirtings, picture or dado rails.

A platform for a building unit is laid horizontally and covered with plaster to a sufficient thickness or depth to provide the required thickness of wall area in the finished building unit. While this plaster is still fluid a sheet or layer of scrim is superimposed and the cut section of cellular core is pressed onto it so that one end of the cells stands thereon and becomes embedded in the layer of plaster thereon, causing the cells to be integrally united with the surface area plaster. When set, the core with the adhering wall area is lifted off the platform and a second layer of plaster is applied thereto or to another platform. The composite unit is then inverted and placed upon the scrim reinforced plaster layer in order to embed the other ends of the cells in the layer of plaster.

This completes the operation for forming a standard unit, and such is lifted off the platform after the second wall moulding operation, when it will be appreciated that the two wall areas are united over the whole of their extent by the cells forming a strong core, which lies with the cell axes at right-angles to said wall areas.

At the margins of a unit, it will be perceived that cavities corresponding with half cells are exposed at the sides and ends of the unit.

For uniting one unit to another edgewise, a series of small holes are bored in the wall area adjacent the junction line so as to penetrate the adjacent cell cavities, and these bores constitute filling holes through which jointing plaster may be poured or extruded through a pressure bag and nozzle or hose under pressure, the plaster as it issues through the holes flowing down to fill the adjacent clearances and cavities; in practice it will be found that the poured plaster will seal the vertical joint between members, requiring only strickling off with a trowel or the like.

In order to reinforce the joint dollies formed of rolled pieces or tags of scrim are inserted in the exposed cavities of one unit and plastered in position, while the protruding end of the dolly is inserted in cavities of the adjoining unit to become incorporated in the jointing plaster during the pouring operation.

When it is desired to join two units at right-angles to one another for a corner or angle in building construction, two units are placed together with their inner edges adjoining without overlapping, so that an exterior view of the junction presents a vertical right-angled internal corner the size of which corresponds with the thickness of the unit. In certain of the cavities of the exposed edges of the units scrim dollies are plastered in position to hold the units temporarily in correct relation. The corner is completed by applying exterior shuttering to form an elongated vertical cavity, square in plan. The vertical cavity thus provided is filled in stage by stage in convenient moulding heights, either with a plaster or with a stronger cement mixture should an additional load carrying capacity be desired.

It will be observed that between any two units placed edge to edge to form a straight wall, a reinforcing column or rectangular post may be shutter moulded; the space between the edges of the units determining the width of the column while the concrete entering the adjacent cell cavities forms keys. This reinforcement may be employed for structural purposes or to increase the load carrying capacity, and the moulded columns or posts may be suitably reinforced with metal if desired.

For a junction of one unit with another to form a T-shaped union (in plan) holes are formed in a wall area plaster of the unit to form the cross piece of the T in the vertical plane of the joint to be formed, at intervals corresponding with the cavities in the exposed edge of the other unit to be joined or with certain of them. In these holes scrim dollies are plastered with their ends protruding which are subsequently fitted into the opposing cavities of the unit when such is brought up to the joint position. Bores

are previously formed near the edge of the unit which is to form the stem of the T union and plaster is poured or extruded through these holes to fill the cavities and adjacent crevices and incorporate the ends of the dollies in the jointing plaster.

Walling units are erected on a site by first preparing the site with a concrete perimeter foundation or deck in which grooves of a suitable width are left for the reception of the lower ends of the building units, which are assembled in the grooves and their footings grouted with cement therein. Alternatively, the units may be erected in the cement foundation or deck *in situ* while such is being poured or moulded. Or the units may stand on a foundation and be cemented thereto by pouring or extruding concrete or cement through bores formed in the wall area so that the cement will fill the cavities and key the units in position on the foundation, whether such be of concrete or in the nature of brick footings.

Although the invention has been heretofore described more particularly with reference to the formation of walling units, similar units may be produced for flooring or roofing areas, the flooring units being supported upon any suitable joists, or joists may be moulded or cast between the units after the manner already described with reference to the junctions of units, and/or one wall area may be moulded of concrete (of a suitable thickness) with or without metal reinforcement. This side of the unit may be used as flooring whilst the plaster moulded side may be utilised for the ceiling of the room.

A similar arrangement may be adopted for roofs, the rafters being of known character, or rafter members being moulded between units on the principles already indicated. The exterior surface of the roof may be of plaster, concrete or cement mixture, and where plaster is used either for exterior surfaces for roofs or exterior walls any suitable waterproofing and weatherproofing coat may be applied, either by spraying or brushing.

Internal partitions or partition walls may be produced in a similar manner to that described for wall units. In this case, however, the axial length of the cellular cores will be suitably reduced.

Provision for windows and doors may be readily made. Where the omission of a standard unit does not provide the required width of opening, units may be sawn or cut back or narrower units introduced to adjust the width of opening. With regard to height of opening, a unit of shorter length is provided or cut and secured in position by jointing with the adjacent units and/or by the use of head beams and lintels and/or sills or the like.

The cellular structure of the unit cores lends itself to the introduction of electric wiring or the installation of piping for services. Wiring may be readily introduced by employing a long rod which may be pointed at one end and have a hook or eye at the other. The rod is used to penetrate the cells laterally from the edge of a unit between the wall areas. After the rod has been passed through a unit or units the cables attached to the rod eye are pulled through into position. In a similar manner, piping may be introduced but in this case the pipes themselves may constitute their own penetrating rod as the cell walls are readily puncturable to admit the passage of the pipes.

Dated this 31st day of January, 1945.

MARKS & CLERK
of
London, Birmingham, Manchester
and Glasgow.

PROVISIONAL SPECIFICATION.

No. 11143, A.D. 1945.

Improvements in and relating to Building Constructions for Roofing, Flooring or other purposes.

We, PERCY FRED BELL, of 20, Sandy Way, Walton-on-Thames, Surrey, a British subject, NORMAN GREENLEES WEIR LOUDON, of Littleton Park, Shepperton, Middlesex, British subject, and SOUND CITY (FILMS) LIMITED, of Sound City, Shepperton, Middlesex, a British Company, do hereby declare the nature of this invention to be as follows:—

This invention relates to building constructions, sectional units adapted to be used for roofing purposes, flooring and ceiling units or surface areas (hereinafter referred to as roofs or roofing), for which, according to the invention, are employed hollow panels or like units enclosing between their faces a cellular core or webs or transverse elements or structures affording cavities or interstices (hereinafter referred to as cells or cellular forms), cellular panels of the character described in our prior Patent Specification No. 2471/1945 being particularly suitable.

The invention has for its object the provision of a reinforced section or unit embodying a set of prefabricated cellular panels which may be assembled and reinforced *in situ*. It will be appreciated that in building constructions the manufacture of prefabricated roofing sections or the moulding thereof *in situ*, according to normal practice, involves

the use of complicated and expensive shuttering and the erection of prefabricated roofing sections (of suitably large area) of reinforced concrete is a laborious operation involving the use of hoisting machinery.

It is an object of the present invention to provide a method and means of construction whereby roofing units may be made by the aid of simplified shuttering means and the roofing in by reinforced concrete of a building or structure may be effected in a convenient and expeditious manner without the use of special hoisting or like machinery suitable for raising and positioning heavy weight units. Hence it is an aim of the invention to provide roofing and the like by the *in situ* formation of roofing areas or units from relatively small units or light units, or alternatively to prefabricate suitably large area roofing and like units composed of sets of light-weight members and reinforcement.

The invention consists in a panel construction comprising surface area light units of plaster, foamed concrete or other composition panels having between their facing a supporting cellular structure (which may be of the form described in the prior Patent Specification referred to above) having rebated margins for the reception of moulded reinforcement. In one form the surface sheet on one side of the panel is substantially less in length and width than that for the other side of the panel so as to afford the panel a continuous marginal rebate, one side of which is constituted by the edge of the smaller panel and the adjacent exposed surfaces and cavities or interstices of the cellular core, while the other side of the rebate is a flange consisting of the extended surface or sheet at the other side of the panel.

The outer surface of a reinforced panel assembly is proofed by applied bitumen or other mastic with or without roofing felting or like material.

The invention also consists in a method of erecting roofs, roofing sections or the like constructions comprising: assembling two, four or more panels as described in the preceding paragraphs together so that the rebated marginal portions adjoin to constitute channels, fixing marginal shuttering, converting the outer rebates to channel form and arranging reinforcing members in the several channels, and pouring concrete thereinto (the applied shuttering and sides of the rebates acting as a mould) to form a reinforced concrete framing for the panels.

The invention also consists in a roofing or like section formed by the method defined in the preceding paragraph and constituting a plurality of cellular panels framed in moulded concrete.

The invention also includes a method erection or *in situ* construction which comprise: supporting cellular panels upon tubes or bearers supported upon the house or building walling, assembled in juxtaposition to provide moulding channels, each assembly being surrounded by appropriate shuttering, and pouring concrete (with or without reinforcement) into said channels; removing the bearers from beneath the roofing structure when the concrete has set, to lower the roofing unit thus formed into position on the walling. After erection the roof may be bitumenised and/or felted or covered with weatherproof material as desired.

The preformed panels may be moulded to afford a flat horizontal surface or such may be formed to provide a slight incline or ramp useful for drainage purposes.

In carrying the invention into effect as described, by way of example, as applied to the provision of so-called flat roofing for a dwelling house or other building, panel units of cellular construction, for example as described in our prior Patent Specification No. 2471/45, are prefabricated each with a rebated surrounding margin. This may be effected by employing a square or rectangular section of the cell-forming core material cut or moulded to expose cell cavities and moulding or uniting surface sheets or areas of plaster or the like to the ends of the cells, the surface sheet on the end of the cells on one side of the panel being three or more inches smaller in length and width than the length and width of the surface sheet or moulding for the other ends of the cells, thus leaving a marginal rebate which is constituted by the extended marginal area of the larger sheet as one side of the rebate and the edge of the smaller sheet plus the exposed cavities of the cellular core as the other side of the rebate.

For roofing purposes, even when forming a so-called flat roof, it is preferred to arrange a unidirectional incline to provide drainage towards a guttering, and accordingly the smaller surface which is intended to lie uppermost in the roofing, instead of being of uniform thickness is made of progressively increasing thickness from one side to the other, while prefabricated panels adapted to constitute adjoining units of a roofing in the direction of drainage have their upper surface sheets of correspondingly progressively increased thickness so that when a series of prefabricated units are placed together in the direction of drainage a uniform slight incline is provided.

In forming a roof of prefabricated panels such as above described, *in situ*, a suitable number of iron tubes or other bearers are laid across the walling of the dwelling to be roofed, these bearers being intended temporarily to support assembled panels while being reinforced *in situ* with concrete. Upon these bearers four or more panels according

to the desired area or section of the area it is desired to roof in, are assembled and laid edge to edge in such a manner that their adjoining rebates form a channel of cruciform character which is adapted to constitute self-contained shuttering for the concrete moulding operation. A narrow shuttering corresponding with the overall thickness of the panels is secured around the periphery of the assembly in order to form the outer or marginal rebates into moulding channels.

At a suitable stage metal reinforcing rods may be laid in the several channels according to known practice, after which a suitable concrete or like mixture is poured into the shuttered and the cruciform channels with the result that an integral concrete reinforcement is provided in the form of an outer frame connected by cruciform inner members, which is also integral with the panels and keyed thereto by the concrete which enters the exposed cell cavities of the core.

By suitably positioning assemblies of panels the whole roofing area may be reinforced together, or the panels may be framed and reinforced with the concrete section by section, adjoining sections being united with adjacent sections by the moulded concrete.

Although in many instances it would be preferred to form the reinforced roofing *in situ* it will be appreciated that prefabricated reinforced cellular panel assemblies may be manufactured in suitably sized sections or units, as it will be appreciated with these sections as the main surface area is composed of light cellular plaster work, such units are not too heavy to handle conveniently and erect in position for a roofing. For roofing areas which require more than one unit the necessary number of units are assembled together on bearers as described above and united by pouring concrete *in situ* to complete the roofing area.

The invention may be applied to the provision and the erection of flooring units or sections which on one side may be covered by or united with tread covering, such as a layer of cement or composition, floor boards or any other suitable known flooring or tread material, while on the other side the sections or units may receive or be prefabricated with plaster ceiling material, ceiling boards or other ceiling forming material.

Dated this 2nd day of May, 1945.

MARKS & CLERK
of
London, Birmingham, Manchester and Glasgow.

PROVISIONAL SPECIFICATION.

No. 12087, A.D. 1945.

Improvements in and relating to Jointing associated with Hollow or Cellular or like Cored Panels or Building Units.

We, PERCY FRED BELL, of 20, Sandy Way, Walton-on-Thames, Surrey, British subject, NORMAN GREENLEES WEIR LOUDON, of Littleton Park, Shepperton, Middlesex, British subject, and SOUND CITY (FILMS) LIMITED, of Sound City, Shepperton, Middlesex, British company, do hereby declare the nature of this invention to be as follows:—

This invention relates to methods of and means for making joints in association with walling or like panels of the type which are hollow or provided with cellular or like cores having transverse internal members affording cavities or interstices.

In our prior Patent Specification No. 2471/1945 a mode of jointing is described in association with panels having a honeycombed cellular core, and the present invention has reference to an extension or modification of the described method of jointing to panels other than such as those referred to in the said specification, and also has reference to the mounting and joint formation of cantilevers, brackets or other structures in panels of the type indicated, the aim of the invention being to provide a method of jointing by a moulding method which is inexpensive, simple, strong and effective, and can be carried out so as to render the jointing inconspicuous or invisible.

The invention consists in the formation of joints by perforating a panel surface area adjacent the joint to be made and pouring or extruding a semi-liquid plaster or cementing composition or semi-liquid resin or plastic with or without comminuted fillers according to the nature and composition of the panels (hereinafter referred to as plaster) through the perforation to fill a cavity within the panel (or panels) and bounded by cellular or like walls, battens or confining members, and subsequently closing the perforation with plaster or in any suitable manner, after which the panel may be painted or finished in known manner.

In jointing panels having cellular or like cores it will be appreciated that the panel edges expose portions or fragments of cell cavities or interstices, and that when two panels are brought together edge to edge for uniting such in alignment, pockets are formed by the fragmentary cells or interstices. These pockets are utilised to receive and form self-contained keys or unions constituted by

the poured or extruded plaster so that the edges of the panels are integrally united together. Other joints are made on the same principle.

In producing the joint above indicated a perforation (or perforations) is drilled or otherwise formed in the surfacing material of one or other (or both) of the panels to penetrate, adjacent the joint, a cell cavity or like space common to both panels. The nozzle of a pouring bag or extruding gun is then introduced into the perforation (or successively into the perforations) and a charge is filled into said cavity which, after setting, forms the desired union.

In order that the extruded plaster may form a continuous union or key the cell walls or confining areas adjacent the joint may, if they do not naturally adjoin, themselves be perforated or opened so that the plaster may flow from one to another or others.

In order to reinforce the joint, when the two panels are assembled together, scrim dollies soaked in plaster may be introduced across the cavities of the adjoining panels, or small rolls of rabbit wire or like reinforcement may be employed which becomes embedded in the extruded plaster filling.

In a similar manner panels may be united at right-angles to one another. For example, in order to make a junction of **T** form in plan, the surface of one panel which is to receive the **T** junction is apertured to receive plaster soaked scrim dollies or rolls of rabbit wire or the like (with or without a fixing plaster clout) which are then introduced into the cavities of the edge of the other panel as it is positioned against the facing area of the first-mentioned panel. Pouring perforations are then formed adjacent the line of the joint in the edge of the panel facing above the uniting dollies or wire. After the formation of the perforations cement is extruded into the cavities around the uniting dollies or wire and allowed to set.

Where hollow panels are to be united which have no convenient cell cavities or confining interstices, a batten is introduced in the hollow portion between the surfaces of each panel and set back from the edge thereof. The batten may be provided with ledges or chocks which are adapted to provide a substitute cavity for the cells referred to above; thus when the two edges of the panels to be joined are brought together confining capacities are artificially formed by the batten formation.

The pouring perforations in panels of this kind are formed adjacent the artificial cavities referred to above and the junction is formed by extruding plaster into said cavities.

In a similar manner **T** joints for hollow panels may be formed by introducing battens or pieces with appropriate cross-pieces in the region of the joint to be formed so that the extruded plaster is suitably confined. Instead of using battens and cross-pieces or the like, plaster soaked scrim pockets may be thrust in the hollow cavity and allowed to set, so that they constitute boundaries for the poured or extruded plaster.

In certain instances, it may be desirable to provide a continuously poured joint, in which case no transverse obstructions need be provided or existing obstructions may be broken down or perforated, in which case the jointing cavity is filled by gravity up to the height of the pouring perforation or perforations.

The external line of the joints is usually filled by plaster exuding between the edge of the joint; this may be finished by smoothing off with a trowel or the like and coated with paint or other finishing material for the wall concerned.

In order to fix cantilevers, walling plugs, shelving, cupboard or other furniture fixtures (hereinafter referred to as cantilevers) in cored panels of the character in question, or in hollow panels with the aid of introduced pockets or pocket forming members, the face of the panel where the cantilever is to be introduced is apertured or slotted to receive the end of the member and a pouring perforation (or perforations) is formed above the cantilever or other object and plaster is extruded until it is seen to exude at the aperture into which the cantilever or the like has been introduced. The extruded plaster unites with the end of the cantilever or the like and integrally moulds such into the panel and forms a secure fixture, the exuding excess of plastic being smoothed off and finished in any desired manner.

Door, window or like framing elements may be similarly secured in position in or between panel units of the character indicated by extruding plaster through perforations or orifices formed adjacent the junction of the framing element with the edge of a panel or framing opening.

Dated this 14th day of May, 1945.

MARKS & CLERK
of
London, Birmingham, Manchester and Glasgow.

COMPLETE SPECIFICATION

Improvements in and relating to Building Units and Building Construction.

We, PERCY FRED BELL, of 20, Sandy Way, Walton-on-Thames, Surrey, British subject, NORMAN GREENLEES WEIR LOUDON, of Littleton Park, Shepperton, Middlesex, British subject, and SOUND CITY (FILMS) LIMITED, of Sound City, Shepperton, Middlesex, British Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention relates to cavitied building panels or slablike units (hereinafter called "units") of the type having numerous tubular cells secured between facings at opposite sides of the unit with the axes of the cells disposed transversely of the facings and the ends of the cells embedded in said facings, and to methods of manufacturing and of utilising such units in building constructions for dwelling houses or other buildings.

The object of the present invention is to provide an improved unit of the type described which is inexpensive to produce and practicable and convenient for modern building purposes, the units being capable of being readily sawn to shape or size and of being connected together homogeneously by plaster jointing. The units possess reasonable load bearing properties although employing materials which are not usually considered suitable for load bearing.

Present-day requirements and conditions, brought about by the war, have created difficult housing problems both with regard to skilled labour and materials. The present invention in addition to its general application is directed towards a solution of such problems, an aim of the invention being to produce a building unit which may be manufactured and erected for walling, roofing or flooring by unskilled or partially skilled labour and in which readily available materials are employed. The improved unit provides for good thermal insulation and reasonable insulation to sound while the facings afford provision for moulded, decorative and like features or finishes, and walling composed of the improved units homogeneously jointed together by plaster has the additional advantage that such becomes a monolithic structure in which crevices and the like, where dust or vermin may lodge, are absent.

The invention consists in a building unit of the type described, comprising a monolithic plaster structure wherein the cells form an integral core the cell-forming walls of which are composed of plastered scrim and wherein plaster facings are moulded onto the ends of the cell walls such that the said ends are embedded in the plaster of the facings.

In the preferred form of unit the facings include a layer of scrim and it is preferred to employ a core composed of corrugated rows of plastered scrim, the corrugated form having flat topped ridges and flat bottomed troughs and wherein the flats of the ridges and troughs of one row are integrally united by plaster to the flats of the next adjacent rows.

The term "scrim" employed herein and in the claims is used to denote not only the open mesh fabric known by that term in the trade but like jute, sisal or other open net vegetable fibre fabrics or equivalent fibrous felted material.

The term "plaster" as used herein and in the claims is confined to a quick setting casting plaster known variously in the trade as fibrous, casting or gypsum plaster or plaster of paris, and the term "plastering" means applying such plaster in the form of a suitable paste to impregnate and coat the scrim with a thin layer (as by brushing, spreading or spattering) sufficient to give rigidity to the scrim such that while the plastered scrim core is light, it has substantial strength when embodied between the facings.

The scrim reinforcement is preferably used throughout the facings for the purpose of sustaining and reinforcing them against shocks during manufacture, transit or erection. This reinforcement holds any damaged portions together and should fracture occur it is localised to the extent of the adjacent cell walls embedded in the facing and the injection of liquid plaster into the cells offers a ready method of repair.

In the accompanying drawings :—

Figure 1 is a fragmentary isometric view showing a moulding means for manufacturing cellular cores according to one form of the invention and illustrating parts of a moulded core in position.

Figure 2 is a diagrammatic isometric view of a core unit such as produced by the moulding means as shown in Figure 1, cut or formed in thickness (dimension B of Figure 1) to suit the building unit for which it is intended.

Figure 3 is a similar view illustrating the application of one facing to the ends of the cells of the core shown in Figure 2.

Figure 4 is an isometric view showing the addition of the other facing to the faced

core unit illustrated in Figure 3 to complete the building unit.

Figures 5, 6 and 7 are diagrammatic sectional views illustrating the moulding means for moulding facings to the ends of the cells of the core unit as shown in Figures 2, 3 and 4, Figure 5 showing the moulding means with the core unit about to be positioned for moulding the first facing, and Figure 6 showing the mould and faced core illustrated in Figure 5 inverted and ready to be positioned upon the lower moulding means to mould the second facing, while Figure 7 illustrates the final moulding stage with the moulding means separated to release the core faced on both sides.

Figure 8 is a side elevation, partly in section, of the upper and lower moulding means in the position for moulding the second facing of the core.

Figure 9 is a fragmentary plan view of the upper mould or mould as shown in Figure 8 and diagrammatically in Figure 5.

Figure 10 is a fragmentary plan view of the lower mould shown in Figure 8 and diagrammatically in Figure 7.

Figure 11 is a diagrammatic sectional view showing the jointing of two units together by injecting plaster by means of a flexible bag.

Figure 12 is a diagrammatic sectional view showing the insertion and injection jointing of shelf-supporting batten means in a cellular unit according to the invention.

Figure 13 is an isometric view of a portion of walling formed of building units according to the invention arranged at a T-junction and illustrating a vertical cavity at the joint for the moulding of a plaster or concrete column.

Figure 14 is a sectional fragmentary view of the horizontal jointing of units for forming a double or cavity wall by the injection method according to the invention and illustrating wire reinforcement.

Figure 15 is a diagrammatic isometric view illustrating units for a double or cavity wall as shown in Figure 14.

Figure 16 is a fragmentary isometric view showing the application of any suitable form of slabs or other exterior cladding applied to walling formed of building units according to the invention and spaced therefrom by ribs formed on the building units to provide further cavitied spaces.

Figure 17 is a fragmentary sectional view and Figure 18 a front elevation illustrating the formation of a double or cavity wall secured together by ties or dollies embedded in plaster in the cells introduced by the injection method.

Figure 19 is an isometric framgentary view illustrating the formation of a floor and ceiling by the use of units according to the invention.

Figure 20 is a side elevation of a roof, floor or ceiling forming unit having a marginal rebate for the channel moulding of concrete reinforcement according to the invention.

Figure 21 is a similar view of a rebated unit having one facing moulded with an inclined exterior surface for providing drainage when the unit is used for so-called flat roofing purposes.

Figure 22 is a fragmentary plan view showing rebated units in position (according to Figures 20 and 21) to form channels for the reinforced concrete beams or the like between units for forming a flat roofing or a flooring with finished ceiling.

Figure 23 is a cross section of roofing according to the arrangement shown in Figure 22 with shuttering for moulding beams in the external rebates in position.

Figure 24 is an end view, partly in section, illustrating rebated units with a moulded concrete beam when employed for ceiling and floor forming purposes.

Figure 25 is a fragmentary plan of the junction of aligned walling units illustrating the casting of a load bearing concrete column or stanchion between the units, employing a portion of the unit facings as shuttering, and

Figure 26 is a fragmentary plan illustrating a similar method of introducing a load bearing vertical member of concrete at a T-junction of walling units.

In carrying the invention into effect according to one mode as described, by way of example, as applied to the production of a standard building unit, moulding means are made for forming the cellular core and platform moulds constructed for producing the facings.

Suitable dimensions chosen for the units according to the present example are as follows :—length 4 ft., width 3 ft. and thickness 4 inches, the facings being about $\frac{1}{2}$ to $\frac{5}{8}$ inch thick. For a 4 inch thick unit the core thickness (axial cell dimension) may be $3\frac{1}{2}$ or $3\frac{5}{8}$ inches and the core is composed of a regular series of uniform cells, the number (in the form exemplified in the drawings) being of the order of 60 complete cells with half cells at the margins, while in other forms there may be as few as 28 complete cells per sq. yard or a square yard may suitably comprise 45 complete cells.

The core moulding means may be formed in wood or metal or other suitable material fixed on mounting boarding or a base 2 and comprise a series of ridges 1 (Figure 1) (of inverted V form with flat apexes) which are arranged parallel and spaced apart to form corresponding troughs or valleys 1*a*, the sectional contour of the ridge and trough form being that of one half of the cells of a row. The floor 1*b* of a trough is flat and corresponds in width with that chosen for one of the shorter sides of the hexagonal shape. The series of troughs and ridges may extend for any suitable length on the dimen-

sion marked A but it may be convenient to form such in lengths corresponding with the height or length of a building unit or a multiple thereof, the longer lengths being readily cut into the standard heights or lengths for the moulded units. The lengths (or axial extent), shown as dimension B (Figure 1), of the ridges and troughs again may conveniently be multiples of the thickness of the cellular core which it is intended to embody between facings, as the cellular structure when moulded may be cut at right-angles to cell axes and the troughs and ridges into suitable core thickness.

Assuming dimension A is for the length of units, dimension C corresponds with the width thereof, but these dimensions may be reversed, i.e. dimension A may correspond with unit widths and dimension C with unit lengths.

At each end of each trough, a loose closure piece 3 is erected which corresponds with the shape of the contour of a trough and extends upwardly to an apex 3*a* at an angle corresponding with the other half of the cell shape. For convenience in manipulating the closure pieces they may have finger holes 3*b*. These end closure pieces 3 have slightly above their widest dimension a pair of small ledge plates 3c inserted in their edges and provided to form footings for hinged ridge forms 4 adapted to be located for the commencement of a second and subsequent rows of cells. The hinged forms comprise a pair of leaves hinged together along one edge as at 4*a*. to provide collapsible ridge-forming members, and may be of wood or metal, the hinge piece being conveniently of cloth where the forms are of wood, and when wood is employed it is preferable to provide them with a covering of American cloth or other protective layer which will prevent sticking of the plaster.

In the region of the hinge the leaves are formed so that when in the erected position their upper edges 4*b* lie flat and are adapted to provide the bottom of the troughs for the next succeeding row of cells to form the shorter cell walls parallel with those of the trough floors 1*b* of the first-mentioned or base mould form. A series of battens 5 are provided for holding the scrim down in the troughs as referred to below, one of which is seen in Fig. 1 in position in a trough for moulding an upper row of cells.

In operation, a web of scrim 6 is laid over the ridges and in the valleys or troughs 1*a* of the base mould form, the scrim being temporarily held down on the floor 1*b* of the troughs by loose battens 5, while the length of scrim is being laid out. Plaster is applied in the form of a paste by spreading, spattering or brushing it on to the scrim throughout the length and breadth of the mould form. In plastering, the scrim over the ridges is first plastered, then the battens are removed and plaster applied to the bottom of the troughs. The plastered scrim forms a corrugated length which provides the lower half of the first row of cells. After plastering, the end pieces 3 are placed in position at the ends of the troughs and the collapsible hinged forms 4 are erected on the footings 3c on the end pieces 3 which remain in position in the troughs 1*a* for forming the moulding ridges and troughs for forming the upper half of the cells. The trough ends between the collapsible ridge forms 4 are subsequently filled by introducing another set of end pieces 3 similar to those already described for the base form. The erection of these hinged ridge forms provides a ridge and trough contour similar to that of the base mould form and a web of scrim 6*a* is laid over these ridges and in the troughs between them, being temporarily held down in the troughs by repositioning the battens 5 referred to above. Plaster 7*a* is applied on to the scrim 6*a* the battens being removed as indicated above. The plaster penetrates the scrim and unites with the plaster 7 of the lower half of the cells to complete the hexagonal form of the first row of cells and form an integral cell structure. Moulding proceeds subsequently for the formation of tiers of rows of cells, additional sets of end pieces 3 and hinge forms 4 being positioned for moulding row by row after the manner seen in Figure 1 with the laying of scrim and plastering stage by stage to form the lower and upper halves of the cells in succession, leaving all the end pieces and hinge forms in position until the required height of cell structure has been built up to correspond with the width of panel or slab unit to be produced, when all the end pieces are withdrawn and the hinge forms extracted endwise after collapsing by folding them, in the same operational step.

When the cellular core formed in the above manner is properly set it is cut into the required lengths for the units midway through the cells and removed from the base mould form, which supports it, and cut at right-angles to the axes of the cells on a band saw according to the thickness predetermined for the standard building unit. Figure 2 shows a completed cellular core for a predetermined standard unit as removed after the moulding and cutting process described above. The length and width of the core are shown by dimensions A and C and the axial cell length or core thickness is indicated by the dimension B and may suitably be about $3\frac{1}{2}$ inches in the present instance while for thicker finished units this dimension is correspondingly increased. The cell cavities and cell walls are denoted respectively by the references 8 and 9, the reference 9*a* being applied to the shorter walls.

These cut sections are next moulded on each side with facing. In Figure 3 the core (as in Figure 1) is first moulded with the facing 10 on one side and then has the facing 11 moulded to the opposite side upon the end of the cells (Figure 4). The area dimensions of the facing are slightly larger than those of the core to afford a jointing clearance 14*b* (Fig. 3) for the flow of jointing material.

This operation is carried out on platform moulds as referred to above. The platforms of these moulds may have a perfectly plain surface when the surface of the facing of the unit is to be of that character, or they may be recessed or provided with ridge mouldings to produce corresponding moulded forms on the exterior surfaces of the units, such as for example to form skirtings, picture or dado rails, panelling or tiling, or with projecting spacers 17 (see Figs. 13 and 16).

The facings moulding operation is diagrammatically indicated in stages in Figures 5, 6 and 7, and the platform moulds are formed in two parts, one part 12 being used for moulding the facing 10 (see Figure 3) and the other part 13 being used for adding the other facing 11 (Figure 4) by inverting the mould 12, with its facing and core in position, upon the mould 13.

The mould 12, seen inverted in Figure 8 and in half plan in Figure 9, comprises a board or like base 12*a* surrounded by a peripheral metal framing 12*b*, the interior of which corresponds with dimensions of the unit to be faced. Each side of the framing has a hinged plate 12*c*, the hinges of which are seen at 12*d*, which may be backed with a wooden piece 12*e* leaving a projecting edge 12*f*. The corners of the pieces 12*e* may be mitred and secured together by a corner clamping device 12*g* (see Figure 9). To provide for the moulding of units of different thicknesses of core the base 12*a* and frame 12*b* are adapted to receive adjustable packing pieces or laminations 12*h* and upon the uppermost layer a moulding platform of any suitable surface material is mounted for the reception of a layer of plaster for forming a facing for the core. The boarding 12*a* is secured at opposite ends to angle irons 12*i* and to two pairs of angle irons or the like 12*j*, the ends of which are extended beyond the frame and notched for the reception of closing clamping means consisting of rods 13*a* hinged at 13*b* to the base bars 13*c* for the other mould 13 which may be fixed to tubes 13*d* or the like mounted on a bench or other support (see Figure 8). The rods 13*a* are screwthreaded and receive apertured loose shoes 13*e* adapted to fit in the notches in the end of the angle irons 12*j*, a handled nut 13*f* being employed to bring clamping pressure to bear.

The mould 13 has a board base 13*g* on which adjustable laminations 13*h* are built up. The mould is surrounded by plate framing 13*i* bound by angle irons 13*j*. The plate framing 13*i* has a lip 13*k* inclined outwardly to receive the edge 12*f* of the first or upper mould.

The working face or platform surface of both moulds is made of or has a coating of smooth material impervious to plaster and, as indicated above, this surface may be plain or it may have moulding formations for decorative purposes, or recesses for the moulding of ribs or bars on the facings of the units.

The platform mould is suitably positioned horizontally as seen in Figure 5 and the platform surface, packed to the desired height, is covered with a layer of plaster to a sufficient thickness or depth (such as $\frac{5}{8}$ of an inch for example) to provide the thickness of facing 10 (see Figure 3) required for the finished building unit. The plaster for facing is of the same kind as used for the cellular core and may incorporate any suitable pigment to give the desired colour finish and may also have mixed in with it an insecticide such as dichlor-diphenyl-trichlorethane. While this plaster is still fluid a sheet or layer of scrim is superimposed to become incorporated as a reinforcement, or the plaster may be laid in two layers with the scrim between. The cut section of cellular core 9 (with dimension B of about $3\frac{5}{8}$ inches) is laid down and impressed into the plaster 10 to a predetermined depth by a suitable straight edge with rebated ends which determine the depth of impression, so that the ends of the cell walls stand thereon and become embedded in the layer of plaster, causing the cells to be integrally united with the plaster which forms one facing for the core unit. When set, the mould 12 with the core and the adhering facing 10 is lifted up, inverted (see Figure 6) and brought down into the position shown in dotted lines, upon the mould 13 which has been previously spread with a plaster layer 11 reinforced with scrim in a similar manner to that described above in connection with the mould 12, for forming the facing 11 (see Figure 4). The edge 12*f* of the mould is fitted into the lip 13*k* and rests upon the packed up platform face of the mould 13, which is plain or decoratively or otherwise formed in relief or intaglio. The clamping rods 13*a* are swung into position with the shoes 13*e* fitted to the notches in the ends of the angle irons 12*j*. The handled nut 13*f* is screwed down, pressing the ends of the cell walling of the core into the layer 11 to ensure the formation of the facing integrally on the core. After completion of the facing moulding the combined mould is opened and the sides 12*c* of the upper mould 12 hinged outwardly to release the core 9 and the upper mould taken away (see exploded view Figure 7).

Mechanical aids may be provided for: raising the mould 12 from the position shown in Figure 5; inverting it and fitting it upon the mould 13 (Figures 6 and 8), and for again raising the mould 12 (or lowering the mould 13) to liberate the faced core (Figure 7).

This completes the operation for forming a standard unit, and such is lifted off, when it will be appreciated that the facings 10 and 11 are united over the whole of their extent by the cells forming a strong core, which lies with the cell axes at right-angles to the planes of the facings. The extent to which the cell ends are embedded in the plaster facings is such as to secure a monolithic union while the cell structure does not show on either facing when dry.

At the margins of a unit, it will be perceived that cavities 9*b*, corresponding with half cells, are exposed at the sides and ends of the unit while a jointing clearance exists at 14*b* between the terminations of the cells and the edge of the facings.

It will be observed that the honeycomb cellular construction described (Figure 2) leaves pockets at the four corners so that the corresponding corner areas of the facings 10 and 11 are unsupported. With a view to affording these corner areas support a piece of plastered scrim 9*d* may be cemented to each of the adjacent core walls 9 when the moulding is in the stage shown in Figure 3, that is to say, when the core is inserted in the facing layer 10 in the mould 12.

For jointing or uniting one unit to another edgewise where it is inconvenient to pour a joint from the top according to known methods, a series of small holes 14 are bored in a facing such as 10 (Figures 11 and 13) adjacent the junction line so as to penetrate the adjacent half cell cavities 9*b*, and these bores constitute filling holes through which jointing plaster may be injected through a pressure canvas or other flexible bag 14*a* with a nozzle or through hose under pressure, the plaster as it issues through the bores 14 in turn flowing down to fill adjacent joint clearances 14*b* (Fig. 3) and cell cavities 8, as seen at 14*c* (Figure 11 which serves also to illustrate a horizontal jointing) where the plaster is filling up a cavity. The injected plaster forms a solid vertical joint between units. The injecting holes may be subsequently filled and the filling plaster smoothed off (see, for example, Figure 14). Horizontal joints between superposed units are made in the same way as in Figure 11 and also in Figs. 14, 15, where units are illustrated for double or cavity walling as referred to later. In each case the plaster filling in the now complete hexagonal cells formed by the half-cells and the joint clearances 14*b*, unites with the interior surfaces of the cells and facings and forms strong keys across the joints.

The above method of making joints and keys by injection may also be applied to the location and securing of cantilevers, brackets, picture moulding, skirtings, furniture or builders' fixtures, shelves and the like, and to the fixing of wall plugs. In Figure 12 a fragmentary section of a wall composed of units according to the invention is shown with a bracket or cantilever such as for a shelf, fixed in position by the injection method. The facing 10 is cut through to provide an aperture or slot to expose a cell cavity into which the bracket 15*a* is introduced, a hole (or holes) 14 is bored above the bracket in the plaster 10 and plaster 14*c* is injected by a bag 14*a*. The plaster on setting in the cell cavity firmly holds the bracket in position. Where larger holding capacity is required cell walls adjacent the cell cavity penetrated by cutting through the facing may be broken or perforated to allow plaster to flow through.

In a similar manner wall plugs may be introduced through the facing of a unit, or where plugs are required in the edge of a unit as in fixing door frames or windows, the plugs are placed in the appropriate half cell cavity and plaster is filled in by aid of an injection bag or by a trowel.

In order to reinforce the joints dowels 15 formed of rolled pieces of chicken wire or the like are inserted in the exposed half-cell cavities of one ~~unit~~ unit and positioned by partly filling the half cells with plaster, while the protruding ends of the dowels enter the opposite half-cell cavities of the adjoining unit when it is placed in position to become incorporated on both sides of the joint in the jointing plaster during the pouring or injecting operation.

When it is desired to join two units at right-angles to one another for a corner or angle in building construction, two units are placed together with their inner edges adjoining without overlapping, so that an exterior view of the junction presents a vertical right-angled internal corner the size of which corresponds with the thickness of the unit. In certain of the cavities of the exposed edges of the units wads of scrim are plastered in position to hold the units temporarily in correct relation. The corner is completed by applying exterior shuttering to form an elongated vertical cavity, square in plan. The vertical cavity thus provided is filled in stage by stage in convenient building heights, either with a plaster or with a stronger cement mixture should a column for additional load carrying capacity be desired.

Where a load bearing vertical column is required between two aligned unit wallings, the cell walls of the half cells in the facing edges of the units and certain adjoining complete cell walls are cut back and removed or folded back between the cheeks of the facings 10 and 11 which form self-contained shutterings. The cutting back is carried out

to such depth as may be required to contain the load bearing material or member. The cavity 16*a* (Figure 25) thus formed is then filled with a suitable concrete 16*b*, metal reinforcement being introduced, where necessary, to form a solid stanchion or column. In the same way, the cavity 16*a* may be formed to constitute a housing for a metal stanchion or column without concrete filling.

For a junction of one unit with another to form a T-shaped union (in plan) holes are bored or otherwise formed in the area of a facing as by cutting away the facing of the unit which is to form the cross piece of the T in the vertical plane of the joint to be formed, at intervals corresponding with the cavities in the exposed edge of the other unit to be joined or with certain of them. In these holes dowels are plastered with their ends protruding which are subsequently fitted into the opposing cavities of the other unit when such is brought up to the joint position. Injecting holes are previously formed near the edge of the latter unit (which is to form the stem of the T union) and plaster is injected through these holes to fill the cavities and adjacent crevices and incorporate the ends of the dowels in the jointing plaster.

Where units are arranged at a T wall junction as in Fig. 13 forming a vertical cavity 16, this may be filled with concrete (reinforced or otherwise) or may be left empty to house a stanchion or post. Where it is desired to cast a substantial load bearing column or post at the T junction the half cells exposed at the edges of the meeting units of the junction and certain of the interior cells may be cut back to the extent required and removed or folded back as in the case of the aligned unit junction referred to above. Fig. 13 also illustrates units with ribs 17 moulded on one facing of the units to act as spacers or distance pieces for positioning panels or other surface area composition boards 18 shown in position in Fig. 16 to form an air space between the panelling and the facing of the units.

Fig. 26 illustrates in plan a load bearing column moulded at a T junction with cell walls cut away to form extended moulding cavities 16*a* between the adjacent portions of the facings 10 and 11 which act as ~~diff~~-contained shuttering. The open portion of the T-shaped cavity is covered by a shuttering board 16*c* and concrete 16*b* is poured into the cavity at the top, with or without the introduction of reinforcement. Instead of filling the cavity it may, if desired, be employed as a housing for the accommodation of a T or other stanchion or post.

Units may be erected to form double or cavity walling or partitions (see Figures 14, 15, 17 and 18) which may be employed for party walls or in other suitable situations. In erecting spaced or cavity walling or partitions, the units are assembled and jointed side by side in superimposition and before positioning oppositely facing pairs of units, the adjacent facings (such as 10, Figure 17) are apertured or slotted opposite selected core cells, and dowels 15 of plaster soaked scrim or chicken wire are inserted. For convenience in insertion the scrim or chicken wire may be wrapped around sticks of wood. In the outer facing 11 pouring holes are bored above the dowels and plaster is injected after the manner already described to fill the cell cavities occupied by the dowels which when the plaster 14*c* is set form securing wall ties. In the elevation, Figure 18, the dowels 15 and plaster filling 14*c* are shown in selected positions as seen through the outer facing 11. This figure also shows the keys filling the adjacent ~~half~~-cell cavities 9*b* at the horizontal and vertical walling joints which are made stage by stage by the injection method as described, preferably with the aid of dowels 15 as seen in Figures 13 and 16. These joints may also be reinforced by wall tying strips of chicken wire 15*b* as shown, for example, in Figures 14 and 15. The wire 15*b* is placed across the edges of the adjacent facings 10 and tucked into half-cell cavities 9*b* and becomes embedded in the plaster 14*c* when it is injected through the holes or bores 14.

Although the invention has been heretofore described more particularly with reference to walling units, similar units may be produced for flooring or roofing areas. Flooring units may be supported upon any suitable joists, or alternatively joists may be moulded or cast between the units.

In Figure 19 is illustrated a suitable mode of applying the invention to flooring. For supporting the flooring and ceiling structure T or other joists or beams are provided, one of which is shown at 19, on one side of the web of which a cellular unit with facings 10 and 11 and exposed half-cells 9*b* is shown supported by way of example. Units are laid on the joists to afford the desired ceiling area with the joints made by the injection or pouring method described, and in order to utilise the joists and form a floor sheets of corrugated iron 20 are laid on the tops of the joists to cover the units, leaving a cavity between the unit facing and the corrugated sheet. When laid these corrugated sheets are covered with a continuous layer 20*a* of concrete to a suitable thickness.

On the upper surface of this concrete when set any suitable flooring board, slabbed or other parquet or tread surface material 21 is laid. The under surface of the facing 11 may form the ceiling of the room beneath. The corrugations of the sheets 20 form an air space or continuous cavity and, if desired, this space may be used for wiring or certain service piping.

According to another method applicable to flooring and to roofs, cellular units instead of being moulded with the facings of equal area are made with one facing 10*a* (Figures 20 and 21) of less dimension than the facing 11*a* by providing suitable positioning means for a smaller mould 12 in the mould 13 to provide a flange or margin extension 11*b* on the facing 11*a*. The facings 10*a* and 11*a* may be made with their outer surfaces parallel or for roofwork the smaller facing 10*a* may be moulded of progressively decreasing thickness as seen in Figure 21, the inclined surface created thereby being in the direction of drainage. Units for adjacent positions are moulded in graded form to form a continuous unidirectional slope when the units are assembled.

The facing 11*a* may be three or more inches longer and wider than the facing 10*a* so that the lateral flanges 11*b* form marginal rebates and these rebates, when a series of units are laid together edge to edge, form concrete moulding channels to provide an integral beam reinforced roof.

In building a roof of prefabricated units such as above described, *in situ*, a suitable number of iron tubes or other bearers are laid across the walling of the dwelling or building to be roofed, these bearers being intended temporarily to support assembled units while being reinforced *in situ* with concrete. Upon these bearers four or more units 19 according to the desired area or section of the area it is desired to roof in, are laid edge to edge (see Figures 22 and 23) in such a manner that their adjoining rebates 11*b* form a channel of intersecting cruciform character which is adapted to constitute self-contained shuttering for the concrete moulding operation. A narrow shuttering 20 (Figure 23) corresponding with the overall thickness of the units, is secured around the periphery of the assembly in order to convert the outer rebates into moulding channels.

At a suitable stage metal reinforcing rods 24 or joists may be laid in the several channels according to known practice, after which a suitable concrete or like mixture 25 is poured into the shuttered and the cruciform channels with the result that an integral reinforced concrete grid is provided in the form of an outer frame connected by cruciform inner limbs, which are also integral with the panels and keyed thereto by the concrete which enters the exposed cell cavities 9*b* of the unit cores. The moulded concrete may be screeded over to level up with the facings 10*a*.

By suitably positioning assemblies of panels the whole roofing area may be reinforced together, or the panels may be framed and reinforced with the concrete section by section, adjoining sections being united with adjacent sections by the moulded concrete. The whole roof area may be finally covered with roofing felt or other sheet material adhesively secured, or with an asphalt or other waterproofing material.

The invention may be applied to the provision and the erection of flooring (see Figure 24) by assembling units (as shown in Figure 20) and arranging them as described in reference to Figure 22. On one side the facing 10*a* may be covered by a layer 26 of reinforced concrete of appropriate thickness on which floor boards or any other suitable known flooring or tread material may be laid with an intervening layer of felt 26*a* if desired, while on the other side the units expose the facing 11*a* which may be plain or moulded suitably for room ceilings.

Provision for windows and doors may be readily made. Where the omission of a standard unit does not provide the required width of opening, units may be sawn or cut back or narrower units introduced to adjust the width of opening. With regard to height of opening, a unit of shorter length is provided or cut and secured in position by jointing with the adjacent units and/or by the use of head beams and lintels and sills or the like. In each case the exposed half-cell cavities of the adjacent units may be utilised for keying plaster in selected cells with dowels or other fixtures moulded in position.

The cellular structure of the unit cores lends itself to the introduction of electric wiring or the installation of certain piping of services. Wiring may be readily introduced by employing a long rod which may be pointed at one end and have a hook or eye at the other. The rod is used to penetrate the cells laterally from the edge of a unit between the wall areas. After the rod has been passed through a unit or units the cables attached to the rod eye are pulled through into position. In a similar manner, certain piping may be introduced but in this case the pipes themselves may constitute their own penetrating rod as the cell walls are readily puncturable to admit the passage of the pipes.

Walling composed of units according to the invention may be combined with any suitable standard walls or building materials, for example 4-inch brick walling may be erected for the outer carcass with the improved unit employed for a lining wall in direct contact with the brickwork or spaced therefrom, preferably by ribs or projections moulded on the facing, the cellular construction affording virtues similar to those of 11-inch cavity brickwork. Wall ties for the brickwork may be readily fixed by accommodating them in the manner already described in reference to the dowels and the injection method. The standard unit may, as hereinbefore indicated, conveniently be 4 inches thick but such may be thinner for partition work or

thicker to provide greater heat and sound insulating qualities; similarly the thickness of the facings of the cores may be varied to suit requirements. The improved units may also be employed as cladding for normal reinforced concrete or steel framed buildings or structures.

Although the invention has been described above in reference to a cellular core in which the cell walls or cell axes extend transversely between the facings at right-angles thereto, a similar result may be achieved where the cell walls or their axes extend transversely between the facings but at an angle less than a right-angle. For example, in cutting the moulded core block, seen in Figure 1, into core thicknesses for core units as seen in Figure 2, such as for building units 4 inches thick, the cuts may be made obliquely instead of in parallel planes at right-angles to the width dimension B of the cells, thereby dividing the block up in parallel planes which lie at say, for instance, 60° or thereabouts across the cell walls and at a corresponding angle to the axes of the cells in the moulded block before cutting. This results in the production of a cell unit of a thickness (dimension B) which, as viewed in side elevation, looks as if it had all its cells pushed over obliquely sideways.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A building unit of the type described, comprising a monolithic plaster structure wherein the cells form an integral core the cell-forming walls of which are composed of plastered scrim and wherein plaster facings are moulded onto the ends of the cell walls such that the said ends are embedded in the plaster of the facings.

2. A building unit of the type described, comprising a monolithic plaster structure wherein the cells form an integral core the cell-forming walls of which are of plastered scrim and wherein plaster facings having an included layer of scrim are moulded onto the ends of the cell walls such that the said ends are embedded in the plaster of the facings.

3. A building unit as claimed in Claim 1 or 2, wherein the cellular core is composed of rows of corrugated plastered scrim, the corrugated form having flat topped ridges and flat bottomed troughs and wherein the flats of the ridges and troughs of one row are integrally united by plaster to the flats of the next adjacent rows.

4. A building unit as claimed in Claim 1, 2 or 3, wherein one facing of the unit is marginally extended beyond the other facing to form a rebate such that in placing units together in the same plane a moulding channel may be formed by the adjoining rebates for concrete or like filling.

5. A building unit as claimed in claim 1, 2, 3 or 4, wherein the exterior of one facing is inclined to the parallel relationship of the facings to afford a drainage slope for roofwork.

6. A method of manufacturing a unit as claimed in Claim 1, 2 or 3, comprising: forming the core by laying a web of scrim over a moulding structure having alternate parallel troughs and ridges; plastering the scrim; erecting collapsible moulds of inverted **V** shape in cross-section over the said troughs to form a superposed ridge and trough mould structure; laying a web of scrim over this mould structure and again plastering the scrim and repeating the operation of erecting collapsible moulds, laying scrim web and plastering such to build up tier by tier an integral core of substantially honeycomb form, collapsing and removing the moulds and applying facings to each side of the core by moulding the facings onto the ends of the cell walls.

7. Apparatus for making a cellular core according to Claim 6, comprising: a base or mounting board having alternate parallel troughs and ridges, a series of sets of mould members for supporting the layers of scrim for plastering, each mould member being of inverted **V** shape when erected and composed of two parts for collapsing in removal from the moulded core, and a series of supports presenting an inverted **V** shape upwardly corresponding to that of the mould members for supporting their ends in the moulding position.

8. A method of manufacturing a unit having a cellular core formed according to Claim 1, 2, 3, 4 or 5, comprising forming facings onto the ends of the cells by moulding one facing to the cell ends by embedding them in a layer of plaster supported on a mould platform and then inverting the core, facing and platform and moulding the other facing to the other ends of the cells by embedding such in a layer of plaster supported on a second mould platform.

9. A method of manufacturing a unit according to Claim 8 wherein a layer of scrim is included in the plaster for the facings previously to embedding the cell ends therein.

10. A method of erecting walling from units as claimed in Claim 1, 2 or 3, assembled to form said walling, comprising pouring liquid plaster or cement in joint clearances or cavities formed between assembled units to form a continuous filling which enters the exposed cells at the edges of the units.

11. A method of erecting walling from units as claimed in Claim 1, 2 or 3, assembled to form said walling, comprising boring holes in a facing adjacent the margin of a unit above the joint to be made and injecting plaster through said holes so that the plaster

thicker to provide greater heat and sound insulating qualities; similarly the thickness of the facings of the cores may be varied to suit requirements. The improved units may also be employed as cladding for normal reinforced concrete or steel framed buildings or structures.

Although the invention has been described above in reference to a cellular core in which the cell walls or cell axes extend transversely between the facings at right-angles thereto, a similar result may be achieved where the cell walls or their axes extend transversely between the facings but at an angle less than a right-angle. For example, in cutting the moulded core block, seen in Figure 1, into core thicknesses for core units as seen in Figure 2, such as for building units 4 inches thick, the cuts may be made obliquely instead of in parallel planes at right-angles to the width dimension B of the cells, thereby dividing the block up in parallel planes which lie at say, for instance, 60° or thereabouts across the cell walls and at a corresponding angle to the axes of the cells in the moulded block before cutting. This results in the production of a cell unit of a thickness (dimension B) which, as viewed in side elevation, looks as if it had all its cells pushed over obliquely sideways.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A building unit of the type described, comprising a monolithic plaster structure wherein the cells form an integral core the cell-forming walls of which are composed of plastered scrim and wherein plaster facings are moulded onto the ends of the cell walls such that the said ends are embedded in the plaster of the facings.

2. A building unit of the type described, comprising a monolithic plaster structure wherein the cells form an integral core the cell-forming walls of which are of plastered scrim and wherein plaster facings having an included layer of scrim are moulded onto the ends of the cell walls such that the said ends are embedded in the plaster of the facings.

3. A building unit as claimed in Claim 1 or 2, wherein the cellular core is composed of rows of corrugated plastered scrim, the corrugated form having flat topped ridges and flat bottomed troughs and wherein the flats of the ridges and troughs of one row are integrally united by plaster to the flats of the next adjacent rows.

4. A building unit as claimed in Claim 1, 2 or 3, wherein one facing of the unit is marginally extended beyond the other facing to form a rebate such that in placing units together in the same plane a moulding channel may be formed by the adjoining rebates for concrete or like filling.

5. A building unit as claimed in claim 1, 2, 3 or 4, wherein the exterior of one facing is inclined to the parallel relationship of the facings to afford a drainage slope for roofwork.

6. A method of manufacturing a unit as claimed in Claim 1, 2 or 3, comprising: forming the core by laying a web of scrim over a moulding structure having alternate parallel troughs and ridges; plastering the scrim; erecting collapsible moulds of inverted **V** shape in cross-section over the said troughs to form a superposed ridge and trough mould structure; laying a web of scrim over this mould structure and again plastering the scrim and repeating the operation of erecting collapsible moulds, laying scrim web and plastering such to build up tier by tier an integral core of substantially honeycomb form, collapsing and removing the moulds and applying facings to each side of the core by moulding the facings onto the ends of the cell walls.

7. Apparatus for making a cellular core according to Claim 6, comprising: a base or mounting board having alternate parallel troughs and ridges, a series of sets of mould members for supporting the layers of scrim for plastering, each mould member being of inverted **V** shape when erected and composed of two parts for collapsing in removal from the moulded core, and a series of supports presenting an inverted **V** shape upwardly corresponding to that of the mould members for supporting their ends in the moulding position.

8. A method of manufacturing a unit having a cellular core formed according to Claim 1, 2, 3, 4 or 5, comprising forming facings onto the ends of the cells by moulding one facing to the cell ends by embedding them in a layer of plaster supported on a mould platform and then inverting the core, facing and platform and moulding the other facing to the other ends of the cells by embedding such in a layer of plaster supported on a second mould platform.

9. A method of manufacturing a unit according to Claim 8 wherein a layer of scrim is included in the plaster for the facings previously to embedding the cell ends therein.

10. A method of erecting walling from units as claimed in Claim 1, 2 or 3, assembled to form said walling, comprising pouring liquid plaster or cement in joint clearances or cavities formed between assembled units to form a continuous filling which enters the exposed cells at the edges of the units.

11. A method of erecting walling from units as claimed in Claim 1, 2 or 3, assembled to form said walling, comprising boring holes in a facing adjacent the margin of a unit above the joint to be made and injecting plaster through said holes so that the plaster

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forms a filling in the adjacent marginal cells.

12. A method of securing cantilevers, wall ties, wall plugs or other features in walling made according to Claim 10 or 11, comprising forming an aperture in a facing of a unit to expose a cellular cavity in the position selected for the feature, forming an injection hole above said aperture, inserting the feature (or the part thereof) to be secured through said aperture and injecting plaster to fill the cavity around said feature.

13. A method of erecting walling composed of units as claimed in Claim 1, 2 or 3, with load bearing columns cast in situ, comprising: cutting and folding back the walls of cells of the cores adjacent the vertical edges of units intended to adjoin the column to form a cavity for casting the columns and expose the adjacent inward sides of the facings to act as self-contained shuttering; bringing the prepared edges of the units together; adding extra shuttering members where necessary to close the casting cavity; and pouring plaster or concrete into said cavity.

14. A method of erecting walling composed of units as claimed in Claim 1, 2 or 3, and pre-erected load bearing columns comprising cutting back the walls of cells of the cores adjacent the vertical edges of units intended to adjoin the said columns to expose inward housing portions of the facings, and bringing the prepared edges of the units together around the columns to house them.

15. A method of forming flooring or roofing of units as claimed in Claim 4 or 5, comprising assembling the units so that the marginal rebates form channels and casting concrete in said channels to form integral concrete beams or frames.

16. A method of forming flooring of units as claimed in Claim 1, 2 or 3, comprising laying bearers of inverted **T** section, laying the margins of the units upon the flanges of the bearers and filling the junction spaces between the bearers and the adjacent cells of the units with concrete.

17. The improved building units substantially as described with reference to the accompanying drawings.

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